# Adaptation to Climate Change

## Policy instruments for adaptation to climate change in big European cities and metropolitan areas

**The study was written by Ecologic Institute, Berlin/Vienna together with AEA group, ICLEI - Local Governments for Sustainability, European Secretariat and the Regional Environmental Center for Central and Eastern Europe (REC).**
**It does not represent the official views of the Committee of the Regions.**

More information on the European Union and the Committee of the Regions is available online at http://www.europa.eu and http://www.cor.europa.eu respectively.

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# Introduction

Adaptation to climate change is increasingly becoming a priority for policy action. In April 2009, the European Commission released a White Paper outlining a proposed framework for action to reduce vulnerability and adapt to climate change (European Commission 2009). The White Paper refers to the importance of a climate adaptation strategy that integrates all areas of regional and municipal development including agriculture, forestry, fishery, energy, public infrastructure (incl. building, transport, energy and water supply), tourism, human, animal and plant health, water resources and ecosystem loss (including marine ecosystems and biodiversity). The paper points to the current piecemeal approach to adaptation, and calls for a strategic overarching EU approach that does not rely on the market or environmental changes alone. Development of the comprehensive EU adaptation strategy will take place from 2009-2012, and will be implemented in 2013. Furthermore, as new policies are developed, it is critical that they are incorporated with the implementation of the EU Cohesion Policy (2007-2013)[1] and the 2007 Leipzig Charter on Sustainable European Cities.[2]

The Committee of the Regions (CoR) endorses the comprehensive approach of the European Commission to climate change adaptation (see CoR Opinion CDR 72/2009). The European framework for action should develop diversified instruments that take account of regional differences in order to reduce the economic, environmental and social impact. It stresses that local and regional authorities must be recognised as key actors in the adaptation process. In order to maximise the effectiveness of action at local and regional level and to ensure a consistent level of adaptation across Europe, it is essential that adaptation should be facilitated by sharing of good practice, information dissemination and assistance to cities and metropolitan areas with tools and data.

Against this background, this study *"Adaptation to Climate Change: Policy instruments for adaptation to climate change in big European cities and metropolitan areas"* aims to evaluate existing best practices based on empirical research of twenty European cities to provide guidance to local and regional administrators and interested stakeholders. The project was structured along three main tasks as outlined in Figure 1. Under Task 1, a literature review was conducted first, which then informed the development of the research design for the study.

[1] EU Cohesion Policy, http://ec.europa.eu/regional_policy/funds/2007/index_en.htm
[2] Leipzig Charter on Sustainable European Cities (2007)
http://www.eu2007.de/en/News/download_docs/Mai/0524-AN/075DokumentLeipzigCharta.pdf

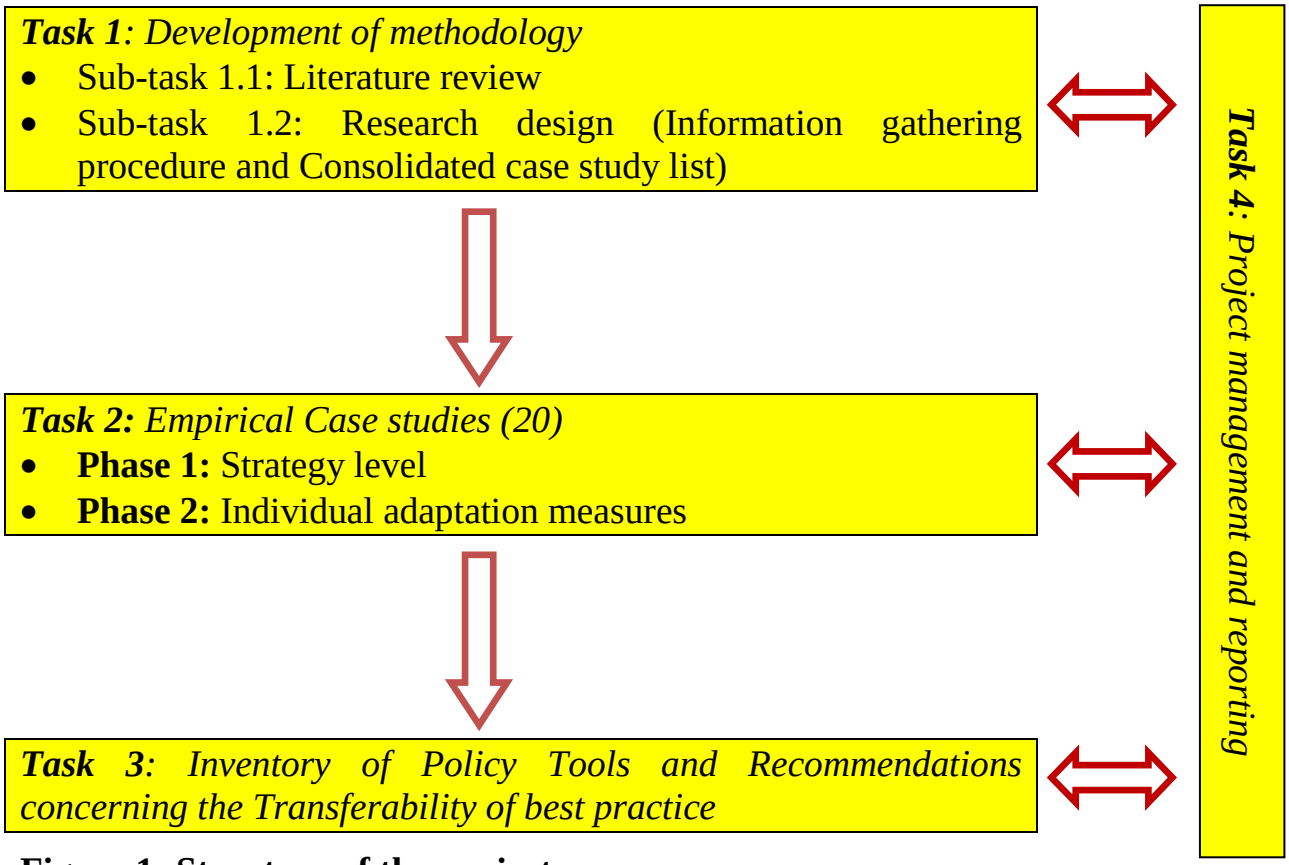


**Figure 1: Structure of the project**

Task 2 was divided into two interview phases in order to enable an overview of the main characteristics of each strategy and a thorough understanding of the features of select key measures introduced by the strategy. In the **first phase** general information was collected on the development process of the strategy, the main adaptation challenges that have been targeted, the resources that have been used in this process and the actors that have been involved. The **second phase** more specifically addressed individual measures within adaptation strategies. This included information on the specific adaptation objectives, synergies and conflicts with other objectives, policy instruments, barriers to implementation and solutions found to overcome them. Results of Task 2 fed the analysis undertaken in Task 3.

The structure of the report is as follows. Chapter 1 presents the findings of the literature review on the issue of climate change adaptation in cities. Chapter 2 describes the case study methodology in more detail. Chapter 3 presents the findings related to overall adaptation strategy development (Phase 1). The chapter includes detailed description and analysis of the twenty case studies in the form of case study sheets. In Chapter 4, the findings related to individual adaptation measures are presented (Phase 2). Chapter 5 concludes with a series of recommendations for both strategy development and the design and implementation of individual adaptation measures.

# 1. Climate change adaptation in cities - literature review

The findings of a short literature review carried out under Task 1.1 of the project are presented below. The review focused on the following 10 key sources[3], which cover the most up-to-date analysis of the emerging literature on climate change and cities.

- Clean Air Partnership (CAP) (2007)
- NordRegio (n.d.)
- Dawson *et al* (2009)
- Lonsdale & McEvoy (2009)
- Ribeiro *et al* (2009)
- ICLEI (2008)
- UKCIP (2007)
- ESPACE (2008)
- Hilpert *et al* (2007)
- Handley & Carter (2006)

The findings have been structured into three sections.

I. Problems facing big cities in the light of future climate change
II. Possible solutions
III. An initial analysis of the key barriers to adaptation at the city level

The 10 key messages from the literature review are:

1. Cities are dynamic and complex systems. Climate change will interact with existing urban problems:
    a. Some problems will get worse
    b. Some new problems will emerge

2. Vulnerability to climate change is concentrated in cities.

3. Urban climate change adaptation strategies must be developed to integrate with -and build on- existing sectoral and cross-sectoral agendas at the city level.

[3] As stipulated in the technical proposal.

4. However, old solutions will not solve new problems; urban adaptation requires innovation, learning and new governance structures.

5. Complexity and uncertainty present real barriers to decision-makers on the ground, particularly given the complex interaction of vulnerabilities at the city level.

6. No single type of measure is able to eliminate vulnerability to climate change; a portfolio approach, for example combining institutional, technological and infrastructure responses, is likely to be most effective.

7. A wide variety of stakeholders need to be involved in the conception, design and implementation of urban adaptation strategies at city level.

8. Cities need leadership, group-working, effective forms of knowledge transfer/ exchange and integrated research to begin the process of adaptation.

9. Opportunities exist; a renaissance in urban design and management could create sustainable and resilient cities.

10. A staggered and iterative approach is required in order to achieve progress in the short term as well as the required step changes in urban management.

**Box 1: Key messages from the literature review**

## 1.1. Problems facing big cities in the light of future climate change

There is a growing appreciation among policy makers and stakeholders of the inevitable impacts that climate change will bring to all regions of Europe. Cities face a specific set of challenges and in many ways will be most profoundly affected by climate variability and change. This is for two main reasons.

- Cities are focal points of vulnerability
- Cities rely on complex infrastructure in order to function (e.g. transport, drainage, water and energy supply); this infrastructure is at risk from climate change,

Dawson *et al* (2009)

The general impacts of climate change in urban areas are widely covered in the literature, largely due to the awareness raised by influential reports such as the IPCC 4th Assessment Report (IPCC, 2007) and the European Environment Agency's Report 'The Impacts of Europe's Changing Climate: 2008 Indicator-based Assessment' (EEA, 2008a).

At the urban level, there are various trends that will interact to produce the challenges, impacts and risks of relevance to decision makers when considering future climate scenarios. These include climate and non-climate problems.

**Table 1: Climate and non-climate problems facing big cities**

| **Climate Problems** |
|---|
| Sea level rise:<br>-Storm surge<br>-Coastal erosion<br>-Saline intrusion in water table<br>-Raised coastal water table<br>-Long-term threat to coastal cities |
| River flooding:<br>-Impact financial districts as well as residential areas<br>-Disruptions and damage to energy, transport and communications infrastructure |
| Flash flooding:<br>-Sewer overload/ back-up<br>-Pollution of groundwater<br>-Economic and social disruption |
| Erratic water supply<br>-e.g. droughts interspersed with floods |
| Drought<br>-Temporary loss of water supply/ water rationing<br>-Increased costs of water supply/ water pricing (affordability concern) |
| Impaired water quality<br>-combination of drought (concentration) and flood (run-off and drain back-up) |
| Heavy rain<br>-Physical damage and disruption |
| Increased wind speeds |
| Heat stress:<br>-Air quality crises<br>-Direct health problems<br>-Waste decay<br>-Peak electricity demand (cooling demand) |
| Disease and pest increases |

| Non-climate problems |
| --- |
| High population density:<br>-Concentrated vulnerability<br>-Overcrowding<br>-Social problems<br>-Drives expansion |
| Urbanisation and expansion:<br>-In-migration<br>-Pressure on services (e.g. health, police) and resources (e.g. utilities)<br>-Urban sprawl: pressure on surrounding ecosystems |
| Impermeable surfaces<br>-High run-off rates<br>-High drainage load |
| Traffic congestion and poor air quality |
| Ageing infrastructure |
| Social inequality |
| Urban heat island |
| Long, global supply chains and just-in-time delivery practices |
| Dependence on electricity supply for most services and security |
| Pressure to de-carbonise urban settlements and economies |

It is the interaction of these climate and non-climate problems that pose significant challenges to urban decision-makers.

Policy solutions that have been prepared to deal with non-climate problems generally do not factor in the climate signal, meaning that they will underestimate the magnitude of the problem they seek to address (CAP, 2007). Below is a selection of examples of how these factors may interact to cause uniquely urban challenges under a changing climate.

**Physical threats**

The integrity of urban areas may be affected by sea level rise and more frequent flooding. Cities on European coastlines, such as the Baltic Coast, are faced with the threat of sea level rise, such as Riga, Latvia (Hilpert *et al*, 2007). Many European cities have developed on the banks of major rivers, which bring risks as well opportunities for trade. The cities of Cologne (1993, 1995), Espoo and Gdansk can testify to the significant economic and social impacts of flooding (Nordregio, n.d.; Hilpert *et al*, 2007). Flooding causes physical damage to assets, buildings and infrastructure, as well as significant and long-lasting financial, social and health disruption.

Most infrastructure in cities is built to last for several decades and was designed using standards that assumed climate was a constant. This includes transport

systems (relied on for commuting, goods and tourism), water and waste water services and a constant supply of electricity, upon which all commercial, public and domestic services depend. Such infrastructures are potentially not able to cope with future conditions, such as increased flood intensity/ frequency or higher average temperatures.

Physical infrastructure may also be ill equipped to deal with adaptation measures themselves. Urban drainage systems require plentiful water to flush and transport waste solids along drainage systems. As a result of drought, but also as a consequence of water efficiency programmes (adaptation), there may be less waste water entering sewers. The consequence is that there may be insufficient water to enable traditional drainage designs to function under changed climate conditions.

As a result of physical threats to cities, weather-related insurance losses are projected to rise over the next years and decades (CAP, 2007). Where development and economic growth continues, the value at stake will rise, meaning that the magnitude of these losses will also become bigger over time. The value of economic growth tends to be focused in cities and therefore the risks of climate change may increase more over time in cities than in suburban and rural areas.

Blue (i.e. water) and green (i.e. grass, forest, fields and parks) areas help to regulate flood water, mitigate urban heat, improve air quality and provide space for sustainable social activities. They are threatened by heat stress and flooding (made worse by climate change) but also by urban sprawl and development; they are the same time becoming more valuable and more threatened.

Urban sprawl is also leading to development within unsuitable locations, such as flood plains (e.g. Handley & Carter, 2006). As the risks associated with flooding increase as a result of climate change (frequency, duration, intensity), this magnifies the vulnerability of settlements.

**Service disruption**

Cities' residents and business require a reliable and safe water supply in order to survive. The drought impacts of climate change, which will be felt throughout much of Europe but most acutely in Mediterranean regions, coupled with the increased demand for water from growing populations, poses significant threats to water supply utilities.

Many European cities are built on ageing and inflexible water and drainage infrastructure. This is difficult and expensive to replace and would pose a problem to city authorities even without climate change. For example, the city

of Panevezys in Lithuania suffers from a history of underinvestment in water supply facilities and associated pollution problems in the river Nevezis. As a result, city residents require private wells to supply drinking water, but these wells are vulnerable when the Nevezis floods, affecting schools, hospitals and other water users in the city (Nordregio, n.d.).

Transport infrastructure is also vulnerable to climate impacts, such as direct flooding impacts, storm damage, heat buckling of train lines and roads, road surface melting and drought causing subsidence damage to roads and rail lines. Urban transport planners are already faced with the challenge of de-carbonising transport whilst coping with increased intra-urban travel and expanding aviation travel activity. Forthcoming low-carbon transport strategies will need to be designed to perform optimally under future climate conditions.

**Opportunities**

Whilst the literature does not focus on the potential upsides of climate change for cities, there are ways in which cities may be able to adapt to seize opportunities. There are marginal benefits from increased average temperatures, which will not require much adaptation, such as decreased cold deaths and smaller financial losses from snow disruption, which, like flooding, costs millions of Euros per day.

Some cities will be able to seize the adaptation agenda as a chance to make their systems and services more efficient and flexible, which should have local economic benefits. Niche industries and sectors will develop to supply the market with adaptive, resilient products and services, bringing employment and investment to cities. Some cities will be able to capitalise on the tourism opportunities presented by seasonal shifts and more flexible holiday planning by consumers.

When seen appropriately in the wider sense of sustainability, the transformational opportunity presented by low-carbon, high-resilience cities is there for the taking; innovative forms of spatial planning, transport and urban ecology may deliver brighter, greener, altogether more pleasant urban spaces offering a high quality of life than the industrial and post-industrial, polluted, congested and socially fragmented cities of the 20$^{th}$ century. Adaptation therefore presents multiple win-win or no-regrets opportunities to cities.

**Indirect impacts**

***Health:*** Urban residents benefit from high levels of access to healthcare and other services whilst suffering from the immediate environmental risks associated with cities, including, most prominently, poor air quality from traffic and industrial activity and increased exposure to noise and heat. This, coupled

with changing disease patterns, the rapid movement of goods and people between outbreak areas, risks to water quality, waste decay and higher risks from ozone in heat waves, make the interaction of various climate and non-climatic factors critical to the future health of urban dwellers.

***Inequality:*** As well as being concentrations of wealth, social inequality is most acutely evident in cities. The various impacts of climate change, as well as existing dynamics around unemployment, crime, social isolation and poor quality housing mean that certain groups are vulnerable to compounding climate factors. For example, low income groups, including young people and older people, have been found to be more vulnerable to flooding (Thrush *et al*, 2005) and heat waves (Brown & Walker, 2008). A body of research is emerging on the links between poverty and vulnerability to climate change (see for example, JRF, forthcoming). Social inequalities are highly likely to increase in cities unless adaptation strategies address this issue directly. Exacerbated social inequality can lead to social unrest, with knock-on effects for politics, security, health and well-being in cities.

***Global impacts:*** Whilst climate change is expected to have a major impact on European cities, the impacts in countries beyond the EU's border, especially in Africa, Central and southern Asia, are expected to be more extreme (IPCC, 2007). Furthermore, these areas are more vulnerable to climate change and so the results will have a more profound and immediate impact on regional economies in the areas surrounding Europe. This is most likely to lead to significant increases in migration to the EU. Migrants aim first to settle in cities, where the prospects of employment and social networks are considerably greater than in rural areas. Big cities in Europe, especially those in the south and with significant migrant populations, will therefore need to prepare for the potential influx of so-called 'climate migrants' over the coming decades.

**Summary**

Urban decision-makers are faced with a number of challenges besides climate change. The bad news is that these challenges will interact and compound, creating dynamic problems for city authorities under conditions of climate change, unless early action is taken to transform Europe's cities.

The opportunity is that the movement towards low-carbon cities and meaningful engagement with the sustainability agenda provide an opportunity to rethink urban spaces for the benefit of urban residents.

The barriers that prevent these problems from being considered as part of routine urban planning are explored in 1.3 below.

## 1.2. Possible solutions

Whilst it is too early to deem any adaptation as 'successful', examples of sensible approaches and 'good practice' are emerging from the academic and policy analysis literature.

**Approaches to adaptation in cities**

The emerging literature on adaptation to climate change in cities recommends a portfolio approach. Dawson *et al* (2009) conclude that no single type of measure is able to eliminate vulnerability to climate change and thereby justify the development of a portfolio of complementary measures, for example combinations of institutional, technological and infrastructure responses. They recommend that the appropriate approach is one centred on the city as a *system*, i.e. influenced by dynamic economic, environmental and social forces. Adaptation can be approached more manageably in this way than at the regional or national level; cities are single entities, albeit with multiple actors and forces at play, as will be seen below. Dawson *et al* promote the integrated assessment approach to studying cities and climate change, as part of the wider Tyndall Centre Cities Programme.

Similarly, Lonsdale *et al* describe the benefits of tackling adaptation within the wider framework of sustainable development in order to gain a better understanding of what constitutes "good adaptation" (2009:16). This includes the consideration of "wider benefits" from adaptation, including social benefits from progressive adaptation measures. In this way, adaptation should be reframed to encompass existing sectoral and cross-sectoral activity on the ground and not be seen as a separate issue or agenda.

Measures taken to adapt to climate change are not always identified as such, nor are they necessarily promoted exclusively by considerations of climate change. In fact, when seen in isolation, 'adaptation measures' may not receive sufficient support at the city level to be implemented. However, when the adaptation agenda is explicitly linked to wider, existing issues, synergies are likely to lead to more adaptive action. For example, urban greening in the UK may not have been a priority for decision-makers previously but adaptation was used as an extra "lever" to give it the prominence it now has in London's urban management agenda (Lonsdale *et al*, 2009:26).

CAP (2007) also promote the idea of "synergies" between adaptation and non-climate issues when approaching adaptation at the city scale. For example, water efficiency was not recognised as a climate change issue, despite one CAP city's reliance on snow melt-fed supply which has decreased by 40-50% in recent

years; now water efficiency is seen as an "insurance policy" against future climate change impacts (CAP, 2007:41).

Despite the clear benefits of linking adaptation to non-climate agendas, CAP (2007) found that no city officials have explicitly considered synergies, although several individual officers with responsibilities for adaptation were aware of potential synergies.

Links between existing sectoral agendas could be made, for example, in spatial planning. By integrating considerations of future climate conditions into spatial plans, planners can increase the resilience of urban spaces in efficient and non-disruptive ways. Heightened flood risk and an exacerbated urban heat island effect (UHI) could be addressed by refraining from developing in flood risk zones, considering heat dispersal in urban layout and prioritising the inclusion of green and blue spaces in plans. Taken further, linking spatial planning to the wider climate change agenda (mitigation as well as adaptation) can lead to reduced fossil fuel-driven transport, with resulting improvements in local air quality, which would further reduce the (health) risks associated with climate impacts (in this case heat waves magnifying the UHI effect) (Dawson *et al* 2009:6). Likewise, considering adaptation alongside mitigation can lead to cost-effective upgrades of the building stock (ICLEI, 2008), especially when modifications are timed to coincide with routine maintenance works.

The emerging literature on climate change and cities therefore recommends taking an integrated approach to adaptation that explicitly embeds existing sectoral and cross-sectoral agendas within the climate change and wider sustainable development framework.

We have identified five key themes from the literature on possible solutions to climate change challenges:

- Leadership
- Stakeholders
- Information and Knowledge
- Adaptation as Learning
- Tools and Guidance

**Leadership**

Achieving adaptation in cities requires strong leadership (CAP, 2007). Strong leadership is often made easier by activity at the city level by researchers or think tanks, giving confidence and momentum to leaders and stakeholders (Lonsdale *et al*, 2009). Interestingly, cities that have engaged with the GHG

mitigation agenda are not necessarily more likely to engage with adaptation (CAP, 2007:10-11).

The Nottingham Declaration Action Pack is one mechanism to demonstrate local government commitment to addressing climate risks, signed by over 300 authorities[4].

Early examples from cities that have engaged with the adaptation challenge suggest that existence of an individual climate change 'Champion' can be key.

> "The importance of having a climate change champion cannot be under-estimated for overcoming barriers and driving the adaptation agenda forward" Lonsdale *et al* (2009:13)

Lonsdale *et al* also highlight the important role of 'policy entrepreneurs' in driving adaptation; that is, leading agents who are searching for problems that require a solution. Examples from adaptation in the Lower Guadiana area of Spain and Portugal and the Tisza in Hungary bear this point out (2009:13).

**Stakeholders**

Whilst key individual agents can play an important role in catalysing and providing leadership to instigate activity, urban adaptation is a process that relies on the buy-in and support of a wide range of stakeholders.

Adaptation has been described as a "process of dialogue" (Lonsdale *et al*, 2009:22). Crucially, a wide range of stakeholders are needed to provide the integrated, linked-up solutions to climate problems. This includes municipal and regional (even national) government departments, transport authorities, utilities (energy and water), conservation groups, urban community organisations, health officials, businesses, emergency services, urban planners, climate, economic and social researchers and others.

The roles of stakeholders are numerous and various when it comes to adaptation.

- Awareness raising
- Involvement in understanding the problem
- Agreeing adaptation objectives
- Securing financial and human resources
- Implementation
- Monitoring and evaluation

(After Ribeiro *et al*, 2009; CAP, 2009)

[4] Available at: http://www.energysavingtrust.org.uk/housingbuildings/localauthorities/NottinghamDeclaration/online_action_pack/?pg=2

CAP (2009) highlight that early engagement of stakeholders is paramount, citing evidence of success in this regard from New York and London. Stakeholder may be brought together informally as part of ad hoc working groups, or, perhaps more effectively, via the creation of climate change agencies or partnerships, for example regional climate change partnerships in the UK (Lonsdale *et al*, 2009), which are considered a factor in improving adaptation planning in London as opposed to New York or Boston, where research teams disbanded following the publication of reports (CAP, 2007). The Swedish Network of Municipalities on Climate Change offers another model (Nordregio, n.d.:18).

**Information and Knowledge**

Adapting to future threats requires the careful treatment of climate and non-climate information in order to create knowledge about risks and possible solutions.

CAP (2007) recommends analysis of historical data and observed trends as a technique for analysing the possible implications of climate change. SNIFFER (2008) and UKCIP have developed the Local Climate Impacts Profile Tool to assist decision-makers in using historical data to aid assessment of vulnerability to future change[5].

The key sources of information for urban adaptation include:

- Modelled projections of future climate change (climate change scenarios);
- Climate impacts modelling at the city level;
- Socio-economic scenarios, including projections of economic growth and population and demographic;
- Details of existing strategies and plans for the urban area covering relevant time horizons;
- Information on past events (see Box 2 above).

The key feature of this information is that it must be presented in a format that is suitable for end users (Nottingham Declaration, n.d.; CAP, 2007; Lonsdale *et al* 2009). The information around climate change can be highly complex. It can also be used inappropriately if the uncertainty and assumptions built in to the data are not properly understood by users, or communicated to stakeholders. Data misuse, or inaccurate data, can lead to maladaptation, which can mean inefficient, ineffective or unjust adaptation.

[5] The tools of the UK Climate Impacts Programme are available online at: www.ukcip.org.uk, including the LCLIP (http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=278&Itemid=377).

In addition to scientific data, city officials require guidance and examples of adaptation from other cities in order to take action. For example, faced with comparatively new risks of heat stress, northern European cities can learn from the solutions employed by Mediterranean cities in maintaining thermal comfort through architecture and the use of shutters and water features to provide cooling (Lonsdale *et al*, 2009:14). This requires systems for sharing and exchanging knowledge around climate impacts and adaptation.

The UK Climate Impacts Programme website acts as a portal for access to climate information, tools, case studies and guidance. This has been seen as a critical success factor in stimulating adaptation at various political levels in the UK (Lonsdale *et al*, 2009). The KOMPASS initiative[6], once fully developed, has the potential to play a similar role for cities in Germany (and beyond) (Lonsdale *et al*, 2009).

The literature places an emphasis on the successful conversion of 'information' into 'knowledge' (e.g. Lonsdale *et al*, 2009:35), recognising that more information does not always help (see Section 3 for more detail on the potential barrier of 'information overload'). Sources such as weADAPT recognise that knowledge-building information is not limited to scientific data, encouraging stakeholders to share experiences and other forms of information. In this sense, despite the obvious need for high quality information and climate and socio-economic data, adaptation can be seen as more of a learning process than a pure data analysis exercise. Improved knowledge transfer systems are therefore required to facilitate adaptation at the city level (Lonsdale *et al*, 2009).

**Adaptation as Learning**

Climate change poses new threats to cities and interacts with existing factors to present bigger problems to city officials. Adaptation therefore requires decision-makers to innovate and deal with new issues.

Lonsdale *et al* conclude that "a central theme … (is) the importance of learning in its different forms" (2009:35). Learning requires more than information, specifically: space and time for innovation, training of staff and stakeholders, a learning atmosphere where honest reflection is encouraged. It is important to recognise this when guiding city officials; one implication is that adaptation must be understood as a process and therefore it is not essential, or even appropriate, to decide all policies and measures at the outset. That is why much of the guidance literature recommends taking an iterative approach to adaptation decision making (see Ribeiro *et al*, 2009).

[6] See http://www.anpassung.net/cln_110/DE/Home/homepage__node.html?__nnn=true

**Tools and Guidance**
Various tools and guidance documents have been prepared to help decision-makers prepare for climate change and to adapt. A selection of these guidance documents, along with examples of regional adaptation projects, is represented in Annex 2.

**Summary**

- Clear institutional mechanisms (including legislation) and organised stakeholder communities are considered important for making progress on adaptation.

- High quality scientific and socio-economic data are a prerequisite for understanding the issues and risks posed by climate change.

- Data and information alone is insufficient for stimulating action; knowledge transfer, exchange and learning mechanisms are necessary for coherent adaptation planning and implementation.

- Approaches to adaptation need to be well considered and not rushed; there is a danger of mal-adaptation if information is misused or the appropriate range of stakeholders is not involved.

## 1.3. An initial analysis of the key barriers to adaptation at the city level

The barriers to adaptation can be divided into conceptual and practical barriers. We will look at each group in turn.

*Conceptual barriers* include specific issues around the nature of the adaptation problem, as well as issues to do with complexity, uncertainty and psychology.

*Practical barriers* include the difficulties of adjusting institutional structures to account for adaptation, identifying and managing diverse groups of stakeholders, issues around information and data gathering and dissemination and the physical constraints of cityscapes.

*Conceptual Barriers*

**The nature of adaptation**
There are various features of the adaptation challenge that present barriers to any decision-maker. Lonsdale *et al* (2009) characterise adaptation as posing a

challenge unlike traditional policy challenges, which may be considered *linear* problems requiring *rational* and *practical* solutions (after Chapman, 2002). Instead, adaptation is a *dynamic* challenge that is *uncertain* and *unbounded*. This leads Lonsdale *et al* (2009) to draw three conclusions about adaptation:

- There is no clear agreement about what exactly the problem is;
- There is uncertainty and ambiguity as to how improvements might be made;
- The problem has no limits in terms of the time and resources it could absorb.

Furthermore, indeed as a result of this lack of clarity, stakeholders question whether financial resources spent on adaptation should not be better invested in reducing greenhouse gas emissions, and thereby reducing the impact of climate change directly without needing to enter in to a dynamic, unbounded policy strategy (ICLEI, 2008:1). However, climate science suggests that a degree of climate change is inevitable, hence EU and MS commitments to the dual objectives of mitigation *and* adaptation (e.g. EU White Paper on Adaptation, European Commission 2009).

There remains a conflict, however, between the perceived value of short-term economic and social benefits from development and expansion and the long term benefits of a potentially more expensive, but more resilient, sustainable revolution of the urban model (Handley & Carter, 2006). There are also a number of pressing non-climate issues for consideration by urban policy makers, which are often seen as more important than climate change, such as the ageing population, terrorism, the global financial crisis or flu pandemics (Lonsdale *et al*, 2009:12).

Adaptation is seen as a 'new' problem' the consequential lack of an agreed framework for assessing adaptation options (Lonsdale *et al*, 2009:30) and monitoring adaptation presents a barrier[7]. The newness of adaptation and the long-term nature of climate change means that it is too early to determine what is 'best practice' and there is a general shortage of case studies to show practitioners what adaptation-in-action actually looks like (Lonsdale *et al*, 2009:32-3). It is certainly too early to be able to evaluate what 'successful' adaptation would be.

Adaptation then, is an unbounded and potentially limitless undertaking, which is likely to deliver benefits over the long term, but which may require the

[7] Despite the prevalence of ideas on what such a framework should look like.

investment of resources in the short term under conditions of uncertainty. Practitioners are still discovering how best to approach adaptation.

**The complexity of climate change, vulnerability and risk**

Climate risks are the result of a significant number of complex factors and interactions. Specifically, risks emerge from complex socio-ecological or coupled human-environment interactions (Lonsdale *et al*, 2009:29). Likewise, vulnerability to climate change is determined by system exposure, sensitivity and adaptive capacity (IPCC, 2007), each of which are in turn dependent on complex interactions of physical and socio-economic factors (see Figure 2).

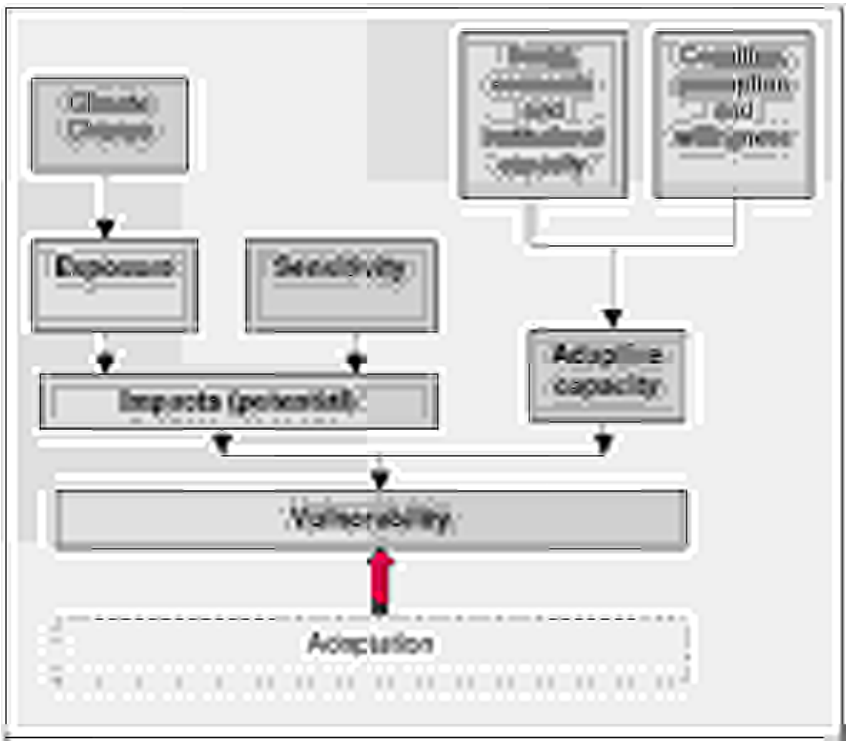


**Figure 2: Vulnerability to climate change, from Schröter et al (2004)**

**Uncertainty in climate science and system response**

Climate modelling is inherently uncertain (Hilpert *et al*, 2007). Scenarios are built on assumptions of future emissions and socio-economic developments, which cannot be known. The complexity of biophysical responses to climate change adds a further layer of complexity. One typical reaction is denial and a refusal to engage (ICLEI, 2008).

Some practitioners hope that improved data will solve the problem of uncertainty (Lonsdale *et al* 2009:28). This is a dangerous mindset because it places an unrealistic faith in climate modelling and impacts science; there will always be a significant degree of uncertainty when modelling such complex systems as future climate change.

Decision-makers sometimes feel paralysed by the uncertainty that is associated with climate projections. This is an equally unhelpful mindset because it rejects the reality of all planning and strategy building, which is that decisions must be made without perfect information. Similar (if not greater) degrees of uncertainty apply to economic forecasting (e.g. interest rates), but do not held back planning in affected sectors (Lonsdale *et al*, 2009:28).

The uncertain timing of future climate impacts makes the planning of implementing adaptation measures difficult, which can hold people back from doing anything at all (ICLEI, 2008). This matter is worsened by the considerable uncertainty that is bound up in existing climatic cycles (e.g. CAP, 2007:41).

The communication of uncertainty is an emerging challenge for climate scientists and adaptation leaders[8].

**Psychological Barriers**

The way in which climate change is perceived and individuals' ability to process information can impede movement towards adaptation.

Perception of risk is critical in motivating adaptive responses. Risk perception, or the awareness of risk (irrespective of the actual degree of risk being faced), can make the difference between action and inaction: 'ignorance is bliss'.

The barriers to adaptation observed from the ADAM project's research in Berlin are relevant in this respect (see Box 2).

Barriers in Berlin

- No state level or local data
- Much of the scientific data is inaccessible, or requires translation for specific audiences
- Political focus on mitigation
- Concern about filling people with fear without providing practical solutions
- Need to learn more and experiment, but no funding for innovation
- Memory of hot summers does not last for long

Lonsdale *et al* (2009:19)

**Box 2: Berlin –Barriers to Adaptation**

[8] For example, the provision of probabilistic climate scenarios in the new UK Climate Projections (UKCP09) have presented additional problems to the teams communicating these results: do practitioners understand and 'treat' uncertainty in appropriate ways? Additionally, functionality comes with a price: additional room for mis-use.

Appetite for risk can also influence adaptation. Cities cannot mitigate all climate risks (budgets are limited) but often fail to explicitly consider their risk appetite. A high risk appetite, for example to encourage spatial development in high risk areas, may inform a decision of whether to, or how much to adapt. Spatial development plans to build 85 000 new homes in the Thames Gateway by London have been assessed in the light of strategic flood risk assessment results to determine an 'acceptable' level of risk for new developments of this kind; insurance firms tend to have a different risk appetite to developers in these circumstances!

Adaptation can sometimes be neglected in cities where climate change mitigation is an existing priority. There is a fear among practitioners that engaging in adaptation may be seen as a sign that mitigation efforts are "inadequate" (Lonsdale *et al*, 2009:11) or that pursuing adaptation is "defeatist" (CAP, 2007). This is more likely to be the case where individual members of staff within the city administration have dual responsibilities for mitigation and adaptation. Mitigation is often seen as more tangible and attractive, whereas adaptation is confusing and represents failure (Lonsdale *et al*, 2009:11).

Other psychological factors inhibit adaptation, including the propensity to forget. This can manifest itself through the short-term memory of administrations who have been affected by extreme weather events, but who soon forget the pain and costs associated and do not take action to prevent such events from occurring again. Tanehill's "Hydro-illogical Cycle" (Londsdale *et al*, 2009:27) shows that that institutional memory of extreme events is short. For example, planning and health authorities have underplayed the risk of heat waves, despite the summer of 2003 heat wave in Central Europe, because of the relatively cool summers of the last few years (JRF, forthcoming).

We have seen that the nature of adaptation is complex and the challenge is long-term, which presents particular problems. In addition, the impacts of climate change on society are highly complex and involve multiple uncertainties, which hamper decision-making and can lead to inaction. Various psychological responses to climate change can also prevent effective action.

We will now consider some of the more practical barriers that have been seen to obstruct progress on adaptation.

*Practical Barriers*

**Institutional context**

Not surprisingly, individual officers can struggle to take account of the relevant sectoral interactions that characterise the threat of climate change. This task

often extends beyond their personal remit within the urban administration, due to the frequent cross-sectoral nature of impacts such as heat waves and flooding (Dawson *et al*, 2009).

Adaptation requires action at multiple administrative scales, for example at conurbation, neighbourhood and individual building level (Lonsdale *et al*, 2009:30). CAP (2007) show that the Boston Metropolitan area consists of 101 towns and city administrations, who are not always willing to cooperate on the scale necessary to enable joined-up adaptation (different administrations may compete for budget and influence).

Adaptation also tends to require action and dialogue at larger scales, which can even be trans-boundary in nature (UNECE, 2009), for example water resource issues and migration. It is often not clear to cities what role they should be playing in adaptation and where specific liabilities lie (ICLEI, 2008:1). It is therefore difficult to initiate action, if the roles and responsibilities, and institutional structures are not in place to enable clear ownership of adaptation planning.

Once adaptation strategies have been designed, there are further institutional barriers to implementation. It is unlikely that the 'portfolio of measures'[9] can be implemented by a single agency within the city administration. The policies and procedures to enable adaptation are not yet in place to allow consideration of the long time scales relevant to adaptation (ICLEI, 2008).

There is also a lack of leadership and investment in adaptation, which prevents progress at the organisational level. High staff turnover in some administrations has been cited as a significant barrier to accelerating progress on adaptation. This leads to both short-termism by individuals and the need for climate champions to repeat their lobbying and capacity building for each new set of colleagues in various positions throughout the organisation (CAP, 2007). The sporadic and insufficient investment in adaptation from national, regional and city authorities is also seen as a barrier to progress, especially given the need to plan for medium to long-term scenarios (ICLEI, 2008; CAP, 2007). The examples in this project shed more recent light on how these factors are playing out in 2010.

A further institutional barrier is presented by the limited remit for spatial planning departments. Planners are able to directly influence new development, and therefore mainstream climate resilience into new plans, but have a more limited role in regeneration and the redevelopment of existing areas. This is

[9] Described above as a necessary approach to adaptation.

increasingly being controlled by the private sector; Handley and Carter (2006) refer to the "privatisation" of open spaces through the increasing involvement of private companies in city centre regeneration. Long term resilience objectives do not overlap with the shorter-term profit interests of private developers.

**Stakeholders**

Sectoral stakeholders will face their own barriers to engagement and action, for example architects may be more cautious about change than some NGO groups (Lonsdale *et al*, 2009:12). Some sectors may find it difficult to reach common positions, due to different sets of interests (e.g. conservation groups and construction companies) or because their approaches are unfamiliar to one another, (e.g. scientists and residents). Different stakeholders may also disagree on the science of climate change (ICLEI, 2008) or the relative importance of competing priorities at the city level. Nevertheless, cooperation and communication between stakeholders is integral to the success of adaptation at any scale (Ribeiro *et al*, 2009).

**Physical limits**

Lastly, cities are constrained by the physical infrastructure upon which they are built, especially the age and inflexibility of certain utility systems such as water mains and drainage systems. The effect is that cities are 'locked-in' to using certain technologies and constrained by the performance capacity of those systems. It is therefore costly and in some cases impractical to build alternative systems or to make sudden switches to alternative technologies, planning systems or infrastructure.

The adaptation measures available to cities are also constrained by the physical layout and characteristics of individual cities. For example, proximity to the coast, floodplains or forests (fire) present risks, but also constrains growth and flexibility. Local soil conditions can reduce the options for simple green space to mitigate flood risk effectively because they contribute to higher levels of run-off, for example clay soils in parts of Manchester (Handley & Carter, 2006).

**Summary**

Adaptation is a new challenge and most city authorities are still working out how best to deal with it. Cities have a number of competing priorities and there are certain features about adaptation that make the task a difficult one.

- Adaptation has no end point; politicians and accountable decision-makers are therefore wary of making a commitment to tackle it.
- Because it involves multiple, non-expert stakeholders, the complexities and uncertainties involved in climate change make the task even harder than it would be anyway.

- Understanding climate is complex; understanding cities under conditions of climate change is even more complex.
- Adaptation requires understanding possible future scenarios; there is a constant balance to be maintained between avoiding 'the paralysis of uncertainty' and underestimating the level of uncertainty in climate science or scenarios.
- Perceptions of risk and vulnerability have a big influence on a city's willingness to adapt.
- Adaptation is seen by some as an admission of failure in climate change mitigation.

This literature review has set the scene of urban vulnerability, risk and adaptation. It raises issues that have further been identified and drawn out from the European case studies during this project. The results of these case studies are presented in the following chapters.

# 2.Case Study Methodology

The consortium partners selected twenty case studies which reflect the diversity of cities and metropolitan areas in the EU in terms of geographic conditions as well as adaptation challenges. Table 2 introduces the selected case study cities.

**Table 2: Cities included in the study**

| Country | Name of city |
|---|---|
| Austria | Vienna |
| Czech Republic | Prague |
| Denmark | Copenhagen |
| United Kingdom | Birmingham |
| United Kingdom | London |
| United Kingdom | Manchester |
| Finland | Helsinki |
| France | Greater Lyon |
| Germany | Bremen/ Bremerhaven/ Oldenburg |
| Germany | Dresden |
| Germany | Hamburg |
| Hungary | Budapest |
| Hungary | Tatabánya |
| Italy | Bologna |
| Italy | Venice |
| Latvia | Riga |
| Portugal | Almada (Lisbon Metropolitan Area) |
| Spain | Zaragoza |
| Sweden | Stockholm |
| The Netherlands | Amsterdam |

As mentioned earlier, the survey was divided into two interview phases: Phase 1 focused on overall strategy development, design and implementation, and Phase 2 on individual adaptation measures. The questionnaires used in both phases are included in Annex 3.

In Phase 1 of the study, local and regional interview partners were first asked to fill in a questionnaire to provide some written information on the relevant topics. Subsequently, the consortium partners conducted telephone interviews with the local / regional partners to clarify and deepen understanding of individual aspects of the adaptation strategy. In many cases it was difficult to identify the appropriate interview partners in city authorities despite well established contacts with cities included in case studies. This is primarily a reflection of unclear allocation of responsibilities on issues of adaptation to climate change. Moreover, it has also proved difficult to obtain the necessary information from city authorities (budget cuts and overworked climate change officers being two of the main explanations). It was important to use many different 'routes' to the city authorities and follow up with multiple requests for information.

The adaptation measures examined in Phase 2 of the survey were selected by the consortium on the basis of suggestions collected in the first phase. The second phase of the survey was conducted analogous to the first phase, i.e. using a questionnaire related to individual adaptation measures and another round of telephone interviews. Depending on the responsibilities for those measures in each administration, the interview partners in phase two may or may not have been the same as in the first phase. This was complemented by desk research conducted prior and/or post-interviews to gain a better understanding of the action, depending on conditions and information available.

Since most strategies are still in the stage of elaboration, most of the potential adaptation measures within these strategies are also only in a planning stage. This provides a significant challenge to derive good practice lessons and recommendations from them. Therefore, the primary focus in the second phase of the study was on measures which have already been implemented or for which implementation has at least already started. In addition, measures which are still in the planning stage are included when they have a strong innovative aspect or are otherwise deemed to be particularly suitable for examination. This selection process resulted in an uneven distribution of measures per city: while an average of two measures per city (i.e. a maximum of 40 in total) was envisaged for further investigation, for some cities more than two measures were included whereas for others one or no measure at all were included.

# 3. Analysis of city adaptation strategies

## 3.1. Overview of results

This section provides an analysis of the main characteristics of city level adaptation strategies examined in the study. The aspects considered are: overall approach, stage of preparation, adaptation challenges identified and addressed by cities, impetus for the development of adaptation strategies, the role of assessments and different tools to support the strategy development, integration of adaptation within existing strategies and structures, stakeholder involvement and consultation, knowledge sharing, barriers and challenges for adaptation planning, and specificities of strategy development in Central and Eastern Europe.

**Overall approach**
Fourteen out of twenty cities in the study have adopted the approach of pursuing comprehensive adaptation strategies (Vienna, London, Copenhagen, Birmingham, Lyon, Manchester, Dresden, Helsinki, Bremen, Tatabánya, Hamburg, Almada, Zaragoza, and Stockholm). Additionally, the city of Bologna plans to begin the process in the near future. In seven of these cities, adaptation and mitigation are being addressed through the same strategy whereas the remaining eight cities are developing or have developed stand-alone adaptation strategies.

The remaining five cities included in the study are applying a set of measures or a sectoral approach without a strategy aiming at comprehensive cross-sectoral integration (Prague, Venice, Riga, Budapest, and Amsterdam). These measures or approaches are not always explicitly framed as adaptation activities and while cross-sectoral integration still takes place, it is more narrow and limited. In particular, the main challenge addressed in these cities is the issue of flooding (Prague) or flooding together with sea level rise (Venice, Riga, Amsterdam). The city of Budapest, on the other hand, has set up a heat wave action plan, which is, however, primarily a local implementation of a national requirement.

**Stage of preparation**
In most cities, adaptation strategies and most individual measures are still in preparation. Only Tatabánya in Hungary and Almada in Portugal have an approved strategy that is already in the implementation stage. Where comprehensive strategy documents are being developed, these are at different stages: under consultation, being prepared, or only in the planning stage. Most strategies are scheduled to be finalised by the end of 2011. The early stages of

development of adaptation strategies limit the potential for the analysis of their content and effects.

**Adaptation challenges**

The study confirms that European cities are facing (or expect to face) several parallel challenges from direct climate change impacts. While five cities (Prague, Hamburg, Budapest, Tatabánya, Riga) indicated a single primary challenge, the remaining fifteen cities identified at least two primary challenges. Moreover, most cities flagged additional challenges. As illustrated in Table 3, river floods, heat waves, and intense precipitation events are reported by approximately half of the case studies as highly relevant challenges from direct climate change impacts. Droughts and water efficiency are also highly relevant. Cities located on the coast, of course, also report the importance of sea level rise. Wind storms are primarily identified as a secondary challenge.

**Table 3: Relevance and coverage of adaptation challenges**

| | River floods | Heat waves/ urban heat islands | Wind / storm damages | Drought and water efficiency | Sea level rise | Intense precipitation, drainage, flash flooding |
|---|---|---|---|---|---|---|
| Most relevant | 9 | 10 | 3 | 8 | 7 | 11 |
| Relevant | 10 | 9 | 13 | 8 | 3 | 7 |
| Covered by strategy | 11 | 10 | 7 | 11 | 3 | 10 |
| Partially covered by strategy | 5 | 4 | 5 | 3 | 2 | 4 |
| | Wild fires | Water quality | Increased health, disease problems | Biodiversity loss | Migration, differential social impacts | |
| Most relevant | / | / | / | / | / | |
| Relevant | 1 | 16 | 16 | 18 | 15 | |
| Covered by strategy | 1 | 8 | 10 | 8 | 7 | |
| Partially covered by strategy | / | 3 | 6 | 5 | 1 | |

Moreover, challenges resulting from more indirect climate change impacts are also highly relevant with three quarters of case studies emphasising the importance of water quality issues, biodiversity loss and increased health and disease problems, as well as migration and differential social impacts.

It is too early and beyond the scope of the study to evaluate how well the individual adaptation strategies respond to the identified challenges. The study does indicate, however, that comprehensive adaptation strategies at least partially address the challenges that they identify as resulting from direct challenges from climate change (i.e. river floods, heat waves, intense precipitation events, sea level rise). This is not as clearly the case for indirect challenges of water quality, biodiversity loss and increased health and disease problems which are not as often fully or partially covered in individual strategies. It is important to note that the evaluation of challenges often reflects the individual opinions of interviewees and may include a bias towards their own areas of work. Furthermore, it is important to stress that for the indirect challenges (especially increased health and disease problems and migration and differential social impacts), no adaptation measures directly targeting them as a primary challenge were included in the Phase 2 of the study. However, it cannot be concluded that cities are not addressing these challenges.

For cities which have not yet begun to develop comprehensive adaptation strategies the presence of multiple challenges clearly indicates a need to move from a sectoral approach to a comprehensive adaptation strategy.

**Impetus for action**

Two main types of impetus for the development of adaptation strategies can be identified: as part of a strategy development guided by municipal governments, or part of research projects (national and international) with the involvement of municipal and regional administrative bodies. Among examples of the former are the cities of London, Birmingham, Prague, Zaragoza and Hamburg. Research projects, on the other hand, are driving forces, for example, in Dresden, Lyon, Manchester, and Hamburg.

The development of city adaptation strategies has, as a rule, not been prompted by binding national level requirements. Most city level actions, however, are linked to a national strategy, either already adopted (Denmark, Finland, France, Germany, Spain, Hungary) or in preparation (Czech Republic, Italy, Latvia, Portugal, Sweden). In the UK, the development of National Indicator 188 which reports on the preparedness to deal with climate change adaptation (see Annex 2) has put pressure on city authorities to address adaptation issues which is further complemented by the regional adaptation strategy adopted in England. Sweden appears to be the only country where funding is provided from the central government directly to the regional authorities to support the preparation of municipal adaptation strategies (not via a research project such as is the case in Germany). This preparation will run in parallel to the national strategy preparation. Among the case study countries, only Austria, the UK as a whole and the Netherlands do not have an explicit national strategy on adaptation.

Research Funding

Research funding has been an important driver for action in the early stages of strategy development in eight of the twenty cities included in the study. A prominent example is the German KLIMZUG programme from the Federal Ministry of Education and Research (see Annex 2), which appears to be an effective approach to coordinating adaptation action between research institutions, administrative bodies, and stakeholders at regional level. It is of central importance in the development of Dresden, Hamburg, and Bremen strategies. The programme has a regional focus as revealed by its title – Managing Climate Change in the Regions for the Future. Regional authorities and businesses provide co-financing, but the large majority of funds come from the federal level. Cities themselves are beneficiaries only as part of the regional project consortium. The KLIMZUG funding is limited to seven pilot regions and represents a one-off injection of funds.

In addition, projects funded under the European Regional Development Fund (for example, BaltCICA in Helsinki, AMICA in Lyon and Venice, and ASTRA in Riga) have been instrumental in encouraging first initiatives and capacity building at local level. The outputs such as scenario developments and risk assessments, even if these do not fully satisfy research needs, along with experiences obtained under these pilot projects can provide a valuable base for the development of strategy documents. Moreover, the University of Manchester plays a central role in facilitating the EcoCities project which provides the framework for the development of Manchester adaptation strategy. In the case of Manchester, however, the primary funding for University involvement comes from the private sector.

Nonetheless, a concern with research-driven activities is how the impetus for action can be maintained beyond the duration of the research project. There is a need to link these individual pilot projects under a national and/or regional umbrella provided by national adaptation strategies and action plans.

The importance of research projects in the initial stages both as a source of funding and guidance for initial (and further) steps in strategy preparation point to the value of guidance, knowledge transfer, and experience sharing. Even in the absence of binding political and legal requirements, central authorities could provide further guidance and funding to facilitate city-level action and provide continuity of adaptation efforts beyond the pilot phase. This is of central importance especially in cases where local expertise is missing. Moreover, given the similarity of adaptation challenges and already established delivery systems for certain policy areas (for example, regional policy), the EU could play an important role in facilitating strategy development at city level.

**Assessments and tools**

The development of adaptation strategies is predicated on the availability of regional and local level data and assessments. Particularly important are the availability of regional climate change scenarios, risk assessments and modelling, impact and vulnerability assessments and mapping tools, as well as economic assessments of action versus no-action. Moreover, other specific needs identified by the case studies include the development of specific locally adapted indicators of risks related to climate change, or the integration of climate models which are downscaled to the regional level with socio-economic scenarios (such as, for example, demographic change). In many case studies, risk assessments, climate scenarios and other tools have been provided through research projects. The development of partnerships with scientific institutions, whether through an externally funded research project or within a city-driven initiative (for example, London) is important for providing the scientific and technical basis for adaptation strategies.

**Knowledge sharing**

Exchange of information and experiences between strategy developers internationally and within the country is important. For example, the city of Vienna is drawing on the experiences of London and Prague on those of Cologne. Further, within Germany both the KLIMZUG programme and the German Federal Environmental Agency contribute to the dissemination of experience.

**Integration of adaptation within existing strategies and structures**

The integration of adaptation objectives with broader sustainable development objectives varies. The comprehensive approaches tend to integrate most sectors, as well as many different types of partners and structures in the design process. A number of cities reported on the integration of adaptation work with the local agenda 21 activities (for example, Birmingham, Lyon, and Zaragoza). The mainstreaming of adaptation actions within existing processes and structures (including mitigation but also sustainable development more broadly) is a best practice message (for example, see the integration concept of Vienna, Helsinki, and Dresden). In Dresden, for example, the emphasis is on mainstreaming adaptation into existing policy areas and administrative departments so that a separate adaptation strategy would not be needed. Adaptation objectives would instead be fully integrated into existing structures. At the same time, sectoral approaches identified in this study (for example, Prague, Lyon, Venice) provide good examples of how cities can develop potential building blocks for adaptation even if under a different label (flooding defence, biodiversity protection).

**Barriers and challenges for adaptation planning**

Central challenges for city authorities in developing adaptation strategies involve the lack of political commitments in the face of other pressing and more immediate challenges, the gap between available scenario and other data and local planning needs, budget cuts and lack of staff, lack of available regional-level data, as well as in some cases the lack of more complete guidance from the national level. Furthermore, adaptation work requires a cross-sectoral approach which can represent an obstacle for local governments if they are not used to this kind of work (see, for example, the case of Zaragoza).

**Stakeholder involvement and consultation**

Cities have applied different approaches to ensure the participation of stakeholders. Where the focus has been on single issues (for example, flooding in Prague or Venice), the involvement is limited to relevant city departments and technical consultants. In the case of comprehensive strategies, most involve the participation of a wide range of stakeholders from city authorities, to private companies, research institutions and citizens' initiatives.

The early involvement and consultation of stakeholders and residents is an important message for best practice (see, for example, Birmingham). The involvement of relevant stakeholders ensures that a comprehensive picture of key challenges and opportunities of climate change is identified, that risks are fully assessed, and that feasibility of adaptation options is tested. Moreover, active participation of stakeholders can improve the buy-in of proposed options and greatly increase the awareness of strategy's importance and the role that it plays.

Some innovative tools to support adaptation include London's website to encourage public comments on the strategy and future actions (including for private homes), the London Resilience Roadmap which sets out 34 actions to help London adapt, or Tatabánya's heat wave alert system.

**Specificities of adaptation in Central and Eastern Europe (CEE)**

<u>Overall approach</u>

The city of Tatabánya, Hungary, is the only of the four CEE cities included in the study which has adopted a comprehensive adaptation strategy. A group of individuals within the local government convinced both the local city council and other stakeholders to integrate mitigation and adaptation in the process of local decision making, resulting in the Local Climate Change Strategy. The remaining three cities have developed and implemented individual measures which have been carried out in the framework of other political processes (for instance, accession towards the EU), in the context of disaster risk management, civil defence, and public health, or as part of large EU-wide projects. For

instance, in Prague the river flood defence system stems from water management and flood defence processes. Budapest has developed its system of Heat Alert in the context the EUROheat initiative. In Riga the coastal flooding forecasts have been developed in the context of an INTERREG III project. While these three cities are not addressing the intensification of frequency and severity of hazards due to climate change explicitly, they do incorporate a safety margin in their planning for disaster and risk management.

Barriers to adaptation

The process of urban adaptation to climate change in Central and Eastern Europe (CEE) has several characteristics, the most interesting of which is that municipalities are adapting to the consequences of climate change without naming it adaptation. The following reasons can provide a strong explanation for why the majority of municipalities have not yet developed comprehensive adaptation strategies:

- Lack of political will due to climate change scepticism and/or mistrust of climate change appeals from authorities.
- Lack of political will resulting from the low priority accorded to environmental issues in municipal agendas and associated lack of available resources (human, financial, etc);
- Low awareness that the environmental hazards occurring in cities can be attributed to climate change which in turn results in low demand for action.

Impetus for action

At present CEE countries do not stipulate the mandatory creation of municipal adaptation strategies. Although, for example, the National Hungarian Climate Change Strategy for 2008-2025, encourages municipalities to do so. It is doubtful whether legal enforcement to create the municipal adaptation strategies can bring their implementation into real life. Soft measures such as awareness-raising, knowledge dissemination (for instance, of best win-win practices and avoided losses due to precautionary adaptation measures), scientific and financial support might be more efficient. Furthermore, the case of Tatabánya clearly illustrates that knowledgeable enthusiastic stakeholders (within the local governments or among general public) play a crucial role in the adaptation process. The existence of such ‘climate leaders’ can become a real vehicle to develop local adaptation strategies and to implement them. It would therefore be appropriate to provide networking and knowledge sharing opportunities to support such climate leaders.

## 3.2. Description and analysis of individual adaptation strategies

**CASE STUDY 1:** **City:** Vienna
**Country:** Austria

**Number of inhabitants (city):** 1 661 206 (2006)
**Strategy at national level:** There is no national adaptation strategy.

**City or regional adaptation strategy:** Programme for climate protection of the city of Vienna (KliP)
*Lead administrative body:* Department of Climate Coordination of Vienna
*Strategy part of combined mitigation and adaptation strategy?* Yes. The adaptation strategy still under development will be part of Vienna´s Climate Change Programme (KLiP).

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* River floods; Drought and water efficiency; Heat waves / urban heat
*Relevant for the region:* Wind / storm damages
*Covered by adaptation strategy:* River floods; Drought and water efficiency; Heat waves / urban heat; Wind / storm damage

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality; Increased health and disease problems; Migration, differential social impacts, Biodiversity loss
*Covered by adaptation strategy:* Water quality, increased health and disease problems; Biodiversity loss; Migration, differential social impacts
*Partially covered by adaptation strategy:* none

**Sectoral coverage:** Comprehensive, cross-sectoral adaptation strategy
*Sectors covered:* Air quality; Health; social life and neighbourhood management; Flood; Water resources management; Soil protection and biodiversity conservation, protection of green spaces; Waste management; Urban and regional planning; Building and construction; Transport; Energy supply and consumption; Regional/Local economy; Tourism and leisure activities; Emergency planning; Finances and insurance.

**Key measures:**
No 1 – House renewal for energy efficiency: Proofing, insulation, overheat control (measure since 1990)
No 2 – Urban planning: spatial planning to reduce climate change impacts and costs, e.g. greening of courtyard, roof (measure since 2003);

No 3 – Plan for security of energy supply: reducing the need for fossil fuel energy as district cooling is done using waste (measure since 2009).

**Resources:**
*How long did/will it take to develop the strategy?* >2 years
*Resources used to develop the strategy*: Financial – information is not available. Personnel – the working groups are now taking their first steps, too early to give precise information about the number of people. External support – too early to give precise information.
*Resources used to implement the strategy:* Financial – administrative budget; Personnel – existing; External support – additional programmes and associated projects.

**Data and information used to develop the strategy:**
*Climate scenarios:* the same scenarios used by the IPCC.
*Climate models:* To forecast for regional level downscaling method will be used. In the course of the "reclip:more" project, the downscaling will be implemented for Eastern Austria. The objective is to project regional climate changes for Austria for long-term periods in a 10 km grid.
*Climate change vulnerability and impact/risk assessments related projects:* Impact of climate change in Vienna under special climate scenarios; "Danubia" assessment (future Danube flow level); Requirements and strategies for adaptation of big cities: the Vienna case study (core topic of interior temperature of buildings).

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* the creation of the strategy.
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy?* Many. See case study comments for details.
*Stakeholders involved in strategy development:*
*Private organisations:* Agriculture insurance (Österreichische Hagelversicherung); Large companies linked to energy production (e.g. OMV); Airport Vienna; Austrian Federal Railways (ÖBB)
*Research institutions:* University BOKU, Meteorology Institute (BOKU-Met); Austrian Energy Agency
*NGOs and/or citizens' initiatives:* Industrial associations; Chamber of Labour; Chamber of Commerce; Caritas; Environmental organisations: WWF, Greenpeace, Global 2000
*Governments of neighbouring cities/regions:* Government of Lower Austria.

**Case study comments**

**Motivation and priorities for strategy development:** The Vienna climate change strategy was started for precautionary reasons. Its priorities for action

were set based on the perception of urgency caused by: high flood vulnerability, results of the vulnerability assessment, availability of resources (human, financial) and as a result of stakeholder consultation.

**Multi-level cooperation and integration with other strategies/policies:** Austria does not have an operational strategy to deal with climate change, and it is not known when the strategy which is now in the pipeline will be approved. A policy paper that is the draft of a possible Austrian climate strategy is available.

The Vienna adaptation strategy is part of a wider climate protection strategy that includes a mitigation strategy. This programme, *Klimaschutzprogramm,* started in 1999 with KLiP I and included 385 measures. KLiP II started in December 2009. This programme creates Vienna´s political commitment to climate change until 2020.

Other city and regional adaptation strategies will be used to inform the design of this strategy such as the adaptation strategy for London.

**Leadership, stakeholder integration and public consultation:** The Vienna city council has a political mandate to develop an adaptation strategy and to submit it to the regional authorities by the end of 2010. However, there is no binding political commitment regarding the implementation and evaluation of the strategy. Gaining political commitment is the major challenge experienced during the stage of creating a strategy.

In 2008, four working groups were defined: Transport, Urban Planning, Building Planning and Tourism. Two working groups on Health and Energy Generation are not yet operational. There are at least nine public departments that will contribute to the creation of the strategy: Vienna public transportation system (Wiener Linien); Vienna Energy Company (Wien Energie); MD-Baudirektion (City's Construction and Infrastructure Department); Wiener Wohnen; Vienna Hospital Association (KAV); MA 18 (Urban Planning), MA 22 (Environmental Protection), MA 3 (Department of Staff Protection and Occupational Health Promotion), MA 17 (Department of Integration and Diversity). There are also four important private sector players (Österreichische Hagelversicherung; OMV; Airport Vienna; Austrian Federal Railways) and six NGOs (Chamber of Commerce, Chamber of Labour, WWF, Greenpeace, Global 2000, Caritas). External stakeholders will participate in the formulation of the strategy through the formation of partnerships between public authorities, research institutes and private organisations.

Some policies and measures were modified to incorporate KLiP requirements: Transport Master Plan Vienna 2003 (MPV); City Energy Efficiency Programme (SEP); City development plan 2005 (STEP 05); The Vienna Integration Concept.

**Monitoring and evaluation:** The climate protection strategy of the City of Vienna will be evaluated annually by the Austrian Energy Agency.

**CASE STUDY 2:** **City:** City of Prague
**Country:** Czech Republic

**Number of inhabitants (city):** 1 200 000 (2008)

**Strategy at national level:** In preparation to be finalised by 2011. However, there are a number of other national strategies addressing various adaptation topics. For instance, Flood Forecasting and Warning System as well as Strategy for Flood Protection are embedded in the Water Act No. 254 adopted in 2001.

**City or regional adaptation strategy:** It is not an adaptation strategy per se. some adaptation measures are spread among different planning departments of the Prague City Hall and Prague Districts Offices. However, the *Plán protipovodňové ochrany hl. m. Prahy* (Flood defence plan of the capital city of Prague) set up in the year 1997 addresses the key challenge from the direct climate change impact threatening the city. Therefore, it can be regarded as an adaptation plan.

*Strategy part of combined mitigation and adaptation strategy?* No

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* River floods
*Relevant for the region:* Heat waves / urban heat islands Wind/storm damages; Intense precipitation, Drought and water efficiency;
*Covered by adaptation strategy:* River floods

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality; Increased number of health problems; Biodiversity loss
*Covered by adaptation strategy:* No

**Sectoral coverage:**
*Sectors covered:* Water resources management; Urban and regional planning; Building and construction; Emergency planning

**Key measures:**
No 1 – Construction of movable barriers along the Vltava River in the historic city centre of Prague
No 2- Construction of dykes and dams in the northern and southern outskirts of the city

**Resources:**
*How long did/will it take to develop the strategy?* >1.5 years
*Resources used to develop the strategy*
Financial - Partly funded from Prague City Hall's own budget, partly from national and EU funding programmes (for instance, from the Cohesion Fund and

the Regional Development Fund). In 1997 a public tender was launched calling on engineering and consultancy companies to submit their proposals for the flood defence system of Prague. The Plan has been prepared based on the winning proposal.

Current costs of implementation of the strategy: approx. CZK 2 000 million in 2006 (approx. € 80 million). Estimated total costs for completion: CZK 3 240 million (approx. € 130 million); Personnel – Prague City Hall; External support – Consultancy companies

**Data and information used to develop the strategy:**
Some models do exist, and they have been used to communicate to the communities near to Prague (both upstream and downstream) that the flood defence system of Prague does not affect their safety.

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* flood protection system of the country
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy?*
*...implementation of the strategy?* National Heritage Institute; Vltava River Basin (Povodi Vltavy) state enterprise - consulting
*Stakeholders involved in strategy development:*
*Private organisations:* Consultancy companies- Water management Development and Construction (building works); Hydroprojekt a.s., Aquatis a.s. (project documentation)
*Research institutions:* T.G.Masaryk Research Institute for Water Management (VUV), Czech Technical University in Prague, Brno University of Technology - comments
*NGOs and/or citizens' initiatives:* Online local floods forums, local governments of communities upstream and downstream of Prague.

**Case study comments**

**General background:** The political process of climate change adaptation in Prague and the whole Czech Republic is in progress. No national or municipal adaptation strategies exist. Instead a series of other strategies address different adaptation issues. For instance, the Water Act adopted in 2001 makes provisions for the flood defence system in the whole country.

**Motivation and priorities for strategy development:** River floods are the key adaptation challenge for the city of Prague. The problem of river flooding is not new for the city. The Vltava River is not only a significant landmark feature but also a constant potential danger to the city centre. Floods can have significant adverse effect on the city centre infrastructure, transportation system, sewage

system, historical monuments and cultural heritage. Measures to protect the city against floods date back to the XIXth century. Attempts to combat urban river flooding started in the late 1990s.

Prague developed a strategy to address flooding: *Plán protipovodňové ochrany hl. m. Prahy (Flood defence plan of the capital of Prague)*. The document itself was first developed in 1997 with a last update taking place in 2008. The implementation of the Plan started in 1998. The completion has been postponed from 2011 until 2013. The plan builds on the example of Cologne, Germany, which had developed a flood defence system after the 1993 flood. This system allowed the city to reduce damages arising from the 1995 flood.

The Prague flood defense system consists of fixed and flexible barriers as well as a flood warning system. The system of fixed barriers consists of eight dams (Vltava cascade) on the River Vltava as well as sliding anti-flood gates within the city itself. The 7.8 km along the Vltava River in the historic city centre of Prague are also protected against floods by the flexible (movable) barriers. The movable barriers are aluminum constructions of 3m high which can be erected within 12 hours along the river bank and removed after flooding. The historical panorama of Prague which is a UNESCO World Heritage Site, thus, remains intact and protected. The Plan describes the steps taken at different degrees of flood threat. For instance, when the flow in Vltava reaches 600 m/second, the anti-flood gates are closed. Vltava River Authority in cooperation with Masaryk Water Research Institute is in charge of flow measurements and flood warning. The elements of the system already in place function efficiently. Prague city centre was successfully protected in August 2002 (while the rest of the city suffered flood damage) when the water flow exceeded 5000 $m^3/s$ which is about 30 times higher than average flow.

**Difficulties encountered and ways to solve them:** It is impossible to build a dyke high enough in the city centre of Prague. The removable barriers provided an effective solution. The movable barriers represent the constructions produced from aluminium; they can be of different shapes and forms in accordance with the needs of a particular architectural landscape. The training of the special team happens once in every five years, and the barriers can be erected within 12 hours along the embankments of the Vltava.

**CASE STUDY 3:** **City:** City of Copenhagen
**Metropolitan Area:** Greater Copenhagen
**Country:** Denmark

**Number of inhabitants (city):** 518 574 (2006)
**Number of inhabitants (metropolitan area):** 1 500 000 (2006)

**Strategy at national level:** Strategy for Adaptation to Climate Change in Denmark (2008, finalised strategy document)

**City or regional adaptation strategy:** Copenhagen Climate Adaptation Plan (2009: first part of the plan, with an identification of the essential problems; the final plan is expected to be approved by the City Council by December 2010)
*Lead administrative body of the strategy:* The City of Copenhagen - Technical and Environmental Administration
*Strategy part of combined mitigation and adaptation strategy?* The strategy focuses mostly on adaptation, even though some measures could be aimed at both results (green roofs, for instance, improve on the one hand the potential to store water in case of intense precipitation and reduce water run-off, while their insulating property reduces the household's energy consumption)

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Sea level rise; Intense precipitation, drainage and flash flooding.
*Relevant for the region:* River floods; Drought and water efficiency.
*Covered by adaptation strategy:* Sea level rise; Intense precipitation, drainage and flash flooding; River floods; Drought and Water efficiency.
*Partially covered by adaptation strategy:* Wind / storm damage.

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality; Increased health and disease problems; Biodiversity loss
*Covered by adaptation strategy:* Water quality; Increased health and disease problems; Biodiversity loss

**Sectoral coverage:**
Comprehensive, cross-sectoral adaptation strategy
*Sectors covered:* Health; Flood and coastal zone management; Water resources management; Soil protection and biodiversity conservation, protection of green spaces; Urban and regional planning; Building and construction; Regional/Local economy; Tourism and leisure activities; Emergency planning; Finances and insurance.

**Key measures:**
Expansion of sewer grid (1st stage of the measure) and setting up of SUDS (SUstainable Drainage Systems): reservoirs to store rain and wastewater, green roofs, "green and blue" elements in the city (2nd stage).

**Resources:**
*How long did it take to develop the strategy?* > 2 years
*Resources used to develop the strategy*: Financial: about EUR 300 000; personnel: use of one full-time employee (1 500 hours) to develop the concept
*How long will it take to implement the strategy:* about 20 years
*Resources to implement the strategy:* financial: hard to say, estimated at EUR 1 billion; personnel: about 80 units (from the City of Copenhagen, Copenhagen Energy, consulting companies, business sector, research institutions)

**Data and information used to develop the strategy:**
*Climate scenarios:* international (IPCC SRES); regionally adapted (downscaling of IPCC reports to local conditions).
*Climate models:* not specified
*Climate change vulnerability and impact/risk assessments:* region specific

**Involvement in strategy development and implementation:**
The main partner, other than the City of Copenhagen - Technical and Environmental Administration - will be "Copenhagen Energy". Several consulting partners and research institutions will participate as well.

A variety of stakeholders will be involved in the implementation of the strategy; mostly private landowners (both citizens and the business sector), urban utilities, local politicians, other municipalities, land use planning authorities and local strategic partnerships. A big contribution is expected from the "Partnership for Climate Adaptation and Innovation" – opened to all stakeholders in the Danish water sector - and committed in the project "Water in Urban Areas" (http://www.vandibyer.dk/english/); the partnership involves members from research and knowledge institutions – e.g. the Technical University of Denmark, public institutions and utility companies, as well as businesses and trade organisations. The main focus will be to test some of the new technologies used for the implementation of the Sustainable Drainage Systems.

## Case study comments

**Multi-level cooperation and integration with other strategies/policies:**
The adaptation plan is part of the Copenhagen Climate Plan, which includes the following goals to be reached by 2015:
Energy → Move from coal to wind generation;
Transport → Move from cars to bikes and hydrogen cars;
Buildings → Achieve higher energy efficiency;

Urban development → Focus on low energy consumption concepts;
Behaviour → Attain a more climate-friendly behaviour of citizens;
Adaptation → Prepare for the expected changes in climate conditions – more intense rain, rising sea level, heat waves.
A longer term goal is a carbon neutral Copenhagen by 2025.

As part of the adaptation programme, the Municipality is implementing new green areas, “pocket parks”, green roofs and walls, which reduce rainfall run-off, thus decreasing the risk of floods. In addition to their remedial function in connection with climate change adaptation, blue and green elements add visual value to the city and highly contribute to the protection of the soil, of green spaces and to the conservation of biodiversity. At least two new pocket parks – small green spaces which help cool the city on hot days and absorb rain on wet days, while opening possibilities for recreational activities as well – are planned to be built each year.

**CASE STUDY 4:** **City:** City of Birmingham
**Country:** United Kingdom

**Number of inhabitants (city):** 1 016 800 (2008)

**Strategy at national level:** In 2008 the Department for the Environment, Food and Rural Affairs launched 'Adapting to Climate Change in England: a Framework for Action'[10].

**City or regional adaptation strategy:** Birmingham Climate Change Adaptation Strategy (in preparation; to be finalised by April 2011)

*Lead administrative body of the strategy:* Birmingham City Council
*Strategy part of combined mitigation and adaptation strategy?* Yes. Commitment to mitigation has always been higher, but ongoing efforts are put into a combined strategy; the strategic framework, therefore, apart from focusing on mitigation, also set out commitments to adapt the city for the future.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* heat waves / urban heat islands
*Relevant for the region:* wind/storm damages; river floods; intense precipitation, drainage and flash flooding; drought and water efficiency;
*Covered by adaptation strategy:* intense precipitation, drainage and flash flooding; drought and water efficiency; heat waves / urban heat islands, river floods; wind / storm damages

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* water quality; increased health and disease problems; Biodiversity loss, migration, differential social impacts
*Covered by adaptation strategy:* water quality, increased health and disease problems; biodiversity loss, migration and social impacts

**Sectoral coverage:**
Comprehensive, cross-sectoral adaptation strategy
*Sectors covered:* air quality; health; Water resources management; soil protection and biodiversity conservation, protection of green spaces; waste management, urban and regional planning; building and construction; energy supply and consumption; regional/local economy; tourism and leisure activities; emergency planning, finances and insurance

**Key measures:**
No 1 - Embedding risk assessment in formal processes
No 2 - Communicating risk and impacts to organisations
No 3 - Implementing neighbourhood adaptation plans using GIS mapping tools

[10] http://www.defra.gov.uk/environment/climate/documents/adapting-to-climate-change.pdf

**Resources:**
*How long did/will it take to develop the strategy?* >2 years
*Resources used to develop the strategy*
Financial - working neighbourhood funds
Personnel – Climate Change Adaptation Officer
External support – Climate Change Adaptation Partnership board member input

**Data and information used to develop the strategy:**
*Climate scenarios: UKCIP09,* Regionally adapted - LCLIP
*Climate models:* GIS mapping tools in development to demonstrate the effects of climate change on the urban heat island, the vulnerabilities and a surface water management plan. Climate change vulnerability and impact/risk assessments: region specific. This includes: GIS-based modelling and assessment of climate change risks and social, environmental and economic vulnerability, covering the urban heat island, flooding and extreme wind to support Birmingham City Council's Resilience Team and partners in identifying and supporting vulnerable communities, businesses and infrastructure; a heat risk assessment to identify Birmingham's urban heat island effect, in conjunction with the University of Birmingham and building on the University of Manchester's ASCCUE project; undertaking a Health Impact Assessment (using Welsh HIA methodology) to understand the health risks of climate change and adaptation options; embedding adaptation and promoting pro-environmental behaviours into staff training, demonstration projects and public campaigns.

**Involvement in strategy development and implementation:**
To prepare for achieving Level 3 of National Indicator 188 by 2011 (one of the main goals of the strategy – more details in the next section) the City Council's Climate Change and Sustainability department is working closely with partners such as the Birmingham Environmental Partnership, the University of Birmingham and the Community Resilience forums. To focus on climate change adaptation, the Birmingham Environment Partnership has also formed a new adaptation sub-partnership. This involves organizations such as the Environment Agency, Natural England, the Forestry Commission, local authorities and planners.

## Case study comments

**General background:** The "Adapting to Climate Change" (ACC) national programme is led by the Department for the Environment, Food and Rural Affairs (Defra) and will be developed in two phases. Phase 1 must: (1) provide more evidence about climate impacts and their consequences on the UK, (2)

raise awareness on the need to take action and help others take action, (3) develop ways to measure success effectively (indicators) and (4) work across government at a national, regional and local level to embed adaptation into government policies. The objective of Phase 2 is to implement a statutory National Adaptation Programme, as required by the Climate Change Bill. Starting in 2012, the programme will report progress to Parliament on a regular basis.

**Motivation and priorities for strategy development:** Birmingham is aiming to achieve level 3 of the National Indicator 188 (see Annex 2). Such achievement would mean that *"the Authority has embedded climate impacts and risks across council decision making. It has developed a comprehensive adaptation action plan (…) and is implementing appropriate adaptive responses in all priority areas. This includes leadership and support for local strategic partnerships in taking a risk based approach to managing major weather and climate vulnerabilities/opportunities across the wider local authority area."*

**Difficulties encountered and ways to solve them:** Political leadership and the combined information and data from partners such as the Fire and Rescue Services, Primary Care Trusts, Environment Agency, Birmingham University, the Resilience Team and community resilience forums have been the main reasons behind Birmingham's success in bringing climate change to the heart of its local strategic partnership. On the other hand, delays in national data (Climate Projections to update climate change risk and vulnerability models) and funding have held back progress; the current economic situation and lack of understanding of the considerable challenges - outside the 'sustainable development world' - has made it furthermore difficult to secure funding for staff within the Council, the Birmingham Environmental Partnership and their partners.

**CASE STUDY 5:** **City:** London
**Country:** England, United Kingdom

**Number of inhabitants (city):** 7 556 900 (2007)
**Number of inhabitants (metropolitan area):** 12 000 000 – 14 000 000 (2007)

**Strategy at national level:** In 2008 the Department for the Environment, Food and Rural Affairs launched 'Adapting to Climate Change in England: a Framework for Action'[11].

**City or regional adaptation strategy:** Climate Change Adaptation Strategy for London: Public Consultation Draft (second draft consultation released on 9 February 2010, closed on 9 May 2010).
*Lead administrative body of the strategy:* Greater London Authority
*Strategy part of combined mitigation and adaptation strategy?* No.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* River floods; intense precipitation, drainage and flash flooding; drought and water efficiency; heat waves/urban heat islands.
*Relevant for the region:* Wind/storm damage; sea level rise.
*Covered by adaptation strategy:* Intense precipitation, drainage and flash flooding; drought and water efficiency; heat waves/urban heat islands; river floods; wind/storm damage.

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Migration/differential social impacts; increased health and disease problems; biodiversity loss.
*Covered by adaptation strategy:* biodiversity loss; migration/differential social impacts; increased health and disease problems.
*Partially covered by adaptation strategy:* Water quality

**Sectoral coverage:**
Comprehensive, cross-sectoral adaptation strategy.
*Sectors covered:* Air quality; health; social life and neighbourhood management; flood and coastal zone management; water resources management; soil protection and biodiversity conservation, protection of green spaces; waste management; building and construction; transport; energy supply and consumption; regional/local economy; emergency planning; finances and insurance.

**Key measures:**
No 1– Improve our understanding and management of surface water flood risk

[11] http://www.defra.gov.uk/environment/climate/documents/adapting-to-climate-change.pdf

No 2– An urban greening programme to increase the quality and quantity of green space and vegetation in London to buffer the City from floods and hot weather
No 3– Retro-fit up to 1.2m homes by 2015 to improve the water and energy efficiency of London homes.

**Resources:**
*How long did/will it take to develop the strategy?* >2 years
*Resources used to develop the strategy:* Personnel – a range of stakeholders including the GLA Group which comprises the London Development Agency, Transport for London, the London Fire and Emergency Planning Authority, the Metropolitan Police Authority and the London Assembly.
*Resources used to implement the strategy:* Personnel – Implementation of actions will fall 50 per cent to the GLA (strategic actions within their remit/responsibility) and 50 per cent to the wider GLA Group.

**Data and information used to develop the strategy:**
*Climate scenarios:* UKCP09.
*Climate change vulnerability and impact/risk assessments:* Region specific vulnerability assessment: a Local Climate Impact Profile (LCLIP, tool developed by UKCIP) has been completed for the whole of London.

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* The GLA Act charges the Mayor with a 'climate change duty', which requires him to assess the consequences of climate change for London and to prepare an Adaptation Strategy.
*Participation of administrative bodies/departments, other than the lead administrative body, in the development of the strategy?* Wider GLA Group (see resources – personnel section above). The strategy calls for ongoing public consultation. An innovative website has been constructed to allow the public to comment on the strategy and make suggestions on its future[12]. In particular, comments are encouraged on what actions Londoners can take to adapt homes, communities and way of life to climate impacts.
*...implementation of the strategy?* Still at the consultation stage.
*Stakeholders involved in strategy development:*
*Private organisations:* businesses including SMEs, transport providers and planners, water suppliers.
*NGOs and/or citizens' initiatives:* Local discussion groups.
*Governments of neighbouring cities/regions:* London Borough administrations.

[12] http://www.london.gov.uk/climatechange/

## Case study comments

**Motivation and priorities for strategy development:** Strategy development was initiated in response to events which have already occurred. Due to the poor understanding of how extreme weather affects London, it was important to have a strategy which would help the city plan to adapt to increasing extreme weather and a changing climate. GLA are going to 'lead by example' with the implementation of their adaptation actions.

**Leadership, stakeholder integration and public consultation:** In the development process, the Mayor of London will engage with business organisations and other key stakeholders to consider how to raise awareness of the need to integrate climate risks and opportunities into their risk management and planning, and whether there is further practical assistance that can be given to London's businesses.

**Multi-level cooperation and integration with other strategies/policies:** During the implementation phase, Brunel University will work with the Mayor to assess and promote 'cool roof' technology. The Mayor will also work with the insurance sector in lobbying government to amend building regulations to require buildings to be made climate resilient. In conjunction with the Environment Agency, 15km of London's rivers will be restored by 2015 through the London Rivers Action Plan. The impacts of climate change on London's health sector will be assessed by the National Health Service London.

The strategy takes a risk-based approach to understanding climate impacts. It provides a framework to identify and prioritise the key climate risks and then to identify who is best placed to work individually or collaboratively to deliver actions. The Roadmap to Resilience sets out 34 actions to help London adapt. These have been selected because the GLA has the greatest ability to influence and implement these in a two-year period.

**Monitoring and evaluation:** In the consultation, views are sought on ways to measure London's progress on adapting to climate change, including indicators and who should measure them. The following issues may trigger the update of the Strategy: 1) publication of new climate projections or sea level rise scenarios; 2) a significant climate-related impact on London; 3) The appointment of a new Mayor; 4) the requirement for the GLA to report to the Secretary of State on adaptation in London under the Adaptation Reporting Power every five years.

**CASE STUDY 6:** **City:** Manchester
**Country:** England, United Kingdom

**Number of inhabitants (city):** 464 200 (2008)
**Number of inhabitants (metropolitan area):** 2 562 200 (2008)

This case study draws on a range of projects underway in Manchester. Projects from which evidence are gathered are:

- EcoCities (Manchester University).
- Green and Blue Space Adaptation for Urban Environments (Manchester University).
- Adaptation Strategies for Climate Change in the Urban Environment (Manchester University).
- Greater Manchester Local Climate Impacts Profile (Manchester University).

**Strategy at national level:** In 2008 the Department for the Environment, Food and Rural Affairs launched 'Adapting to Climate Change in England: a Framework for Action'[13].

**City or regional adaptation strategy:** By the end of 2011, EcoCities aims to have developed a blueprint for Manchester's climate change adaptation strategy. *Lead administrative body of the strategy:* The University of Manchester, rather than Manchester City Council, are leading adaptation planning in Manchester. *Strategy part of combined mitigation and adaptation strategy?* No, it will be a stand-alone adaptation strategy. However, Manchester City Council and Manchester University are developing a formal Memorandum of Understanding to develop a robust response to climate change mitigation and adaptation.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Intense precipitation, drainage and flash flooding; drought and water efficiency; heat waves/urban heat islands.
*Relevant for the region:* River floods; wind/storm damage; sea level rise.
*Covered by adaptation strategy:* These challenges are relevant to Manchester but the strategy has not yet been developed and so cannot address them.

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Biodiversity loss; water quality; migration, differential social impacts.
*Covered by adaptation strategy:* As above.

**Sectoral coverage:** The strategy will be a comprehensive, cross-sectoral adaptation strategy.

[13] http://www.defra.gov.uk/environment/climate/documents/adapting-to-climate-change.pdf

**Key measures:** It is too early to define the key measures.

**Resources:**
*How long did/will it take to develop the strategy?* It will have taken >2 years to develop the strategy.

**Data and information used to develop the strategy:**
*Climate scenarios:* UKCP09 will be used.
*Climate change vulnerability and impact/risk assessments:* A region-specific risk assessment will be used to inform the development of Manchester's adaptation strategy. Exposure units, hazards and elements at risk have been defined by EcoCities[14] as follows:

| Exposure unit | Hazards | Element at risk |
|---|---|---|
| Built environment | Flooding, landslides | Buildings, infrastructure and services |
| Urban green space | Drought, water runoff, temperature | Green networks including parks and gardens |
| Human comfort | Temperature (maximum night and day), precipitation | Population density and characteristics |

A region-wide vulnerability assessment, the Greater Manchester Local Climate Impacts Profile[15] (GM-LCLIP), is also being undertaken to inform Manchester's adaptation strategy. The GM-LCLIP will identify the services most at risk from climate change in Manchester. It will also assist Manchester City Council in planning to adapt to climate change which is required under the performance assessment regime for local authorities, National Indicator 188 (see Annex 2).

**Involvement in strategy development and implementation:**
*Stakeholders involved in strategy development*
*Research institutions:* 'Green and Blue Space Adaptation for Urban Environments'[16] requires stakeholder and community engagement, as well as the development of regional policy networks. Thematic seminars, study visits, and a mentoring programme as well as the opportunity to trial a climate assessment tool will be used to engage stakeholders. The EcoCities initiative is based on extensive stakeholder engagement and best practice examples of new programmes successfully piloted between 2008 and the end of 2011.

[14] http://www.ecocitiesproject.org.uk/ecocities/page.aspx?id=590
[15] http://www.sed.manchester.ac.uk/architecture/research/ecocities/projects/coreprojects/Core_GM_LCLIP.pdf
[16] http://www.grabs-eu.org/partnerdetail.php?id_ptn=2

## Case study comments

**Multilevel cooperation and integration with other strategies/policies:** The development of Manchester's adaptation strategy will be part of a regional integrated management approach through the Adaptation Strategies for Climate Change in the Urban Environment programme[17]. The programme will determine the extent and spatial patterns of green space; provide quantitative estimates of surface and air temperatures, air quality, surface runoff and rainwater infiltration in relation to green space; clarify the vulnerability of urban green space and investigate the potential of green space to adapt to climate change.
The feasibility of adaptation strategies will be tested at workshops involving local and national stakeholders. A scoping study will identify potential interactions between preferred adaptation and mitigation responses.

**Leadership, stakeholder integration and public consultation:** Following the launch of EcoCities in July 2009, a stakeholder workshop took place to begin the process of developing the adaptation blueprint for Manchester. Participants included representatives from the public and private sectors in the North West region, who debated the key challenges and opportunities of adapting the city region to climate change.
A period of stakeholder mapping and policy review will be carried out in conjunction with stakeholders who have an interest in climate change adaptation. The network will be 'live' and will expand to include new stakeholders where appropriate. The map will include national and regional government agencies with a presence in the North West; Greater Manchester sub-regional stakeholders; non-governmental organisations operating in the region, research organisations, private sector businesses and community groups.
There is also ongoing public consultation into the socio-economic impacts of climate change which will be led by the Centre for Urban Regional Ecology at Manchester University. An understanding of the likely socio-economic impacts will be fully integrated within Manchester's adaptation strategy.

**Monitoring and evaluation:** Adaptation planning progress in Manchester will be monitored through National Indicator 188 as discussed above. The EcoCities team, in partnership with Red Rose Forest, provided support to Manchester City Council in reaching level 1 of NI 188.

[17] http://www.sed.manchester.ac.uk/research/cure/research/asccue/

**CASE STUDY 7:** **City:** City of Helsinki
**Metropolitan Area:** Helsinki Metropolitan area
**Country:** Finland

**Number of inhabitants (city):** 576 632 (2009)
**Number of inhabitants (metropolitan area):** 1 022 139 (2009)

**Strategy at national level:** The National Strategy for Adaptation to Climate Change (2005)

**City or regional adaptation strategy:** Helsinki Metropolitan adaptation Strategy in preparation, to be finished in 2011.
*Lead administrative body of the strategy:* HSY Helsinki Region Environmental Services Authority
*Strategy part of combined mitigation and adaptation strategy?* No, stand-alone adaptation strategy. Helsinki Metropolitan area has a climate change mitigation strategy that was published in 2007 at that time it was decided to have a separate adaptation strategy by 2011.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Sea level rise; Intense precipitation, drainage and flash flooding; Wind / storm damage
*Relevant for the region:* River floods, Heat waves / urban heat islands
*Covered by adaptation strategy:* All

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Migration, differential social impacts, increased health and disease problems;
*Partially covered by adaptation strategy:* Increased health and disease problems; Biodiversity loss, water quality, Migration

**Sectoral coverage:**
Comprehensive, cross-sectoral adaptation strategy. It focuses on cross-sectoral impacts, not sectoral
*Sectors covered:* Flood and coastal zone management; Water resources management; waste Management, Urban and regional planning; Building and construction; Transport. Sectors have not yet been fully determined.

**Key measures:** Not yet defined.

**Resources:**
*How long did/will it take to develop the strategy? 1*< 2 years
*Resources used to develop the strategy*
Financial- EU Project to cover some funds
Personnel – EU Project to cover some personnel costs

External support –EU project with research institutes and local authorities as peer resource
*Resources used to implement the strategy:* no response

**Data and information used to develop the strategy:**
*Climate scenarios:* IPCC regionally adapted
*Climate models:* IPCC, SERES, A2, B1, A1B on climate and sea level rise, river models upcoming
*climate change vulnerability and impact/risk assessments:* Region specific

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* The commitment comes at the end of the process of developing the strategy
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy?* Most relevant municipality sectors from different cities of the metropolitan area.
*implementation of the strategy?* There are a few adaptation actions happening at the local level, regional strategy will be published 2011
*Stakeholders involved in strategy development*

*Research institutions:* The Finnish Meteorological Institute provided regional climate scenarios, the Finnish Environment Institute is providing river models for two different rivers, and the Centre for Urban and Regional Studies as partner in the BaltCICA project is providing support on governance issues

## Case study comments

**General background:** The issue of adaptation is fairly new in Finland so there are few actions already being implemented. Municipal adaptation under preparation, there are a few adaptation actions happening on the local level. Climate mitigation strategy (Climate Strategy for Helsinki Metropolitan Region 2030) published in 2007 at that time it was decided to have a separate adaptation strategy

**Leadership, stakeholder integration and public consultation:** The BaltCICA project (see Annex 2) is strongly linked with the development of an adaptation strategy for the Helsinki Metropolitan region. As partner in BaltCICA the task of the Centre for Urban and Regional Studies (YTK) is to develop adaptation options in close cooperation with the cities of the Metropolitan area. The results will enter the adaptation strategy. The tasks are the following:

- Climate change scenarios for the area will be developed
- Possible impacts of climate change in the area will be identified, with a focus on urban built-up areas, urban environment and coastal areas

- Possible adaptation options will be developed and the options will be appraised

The task of the city of Helsinki in BaltCICA is to:

- work in close co-operation with Helsinki Metropolitan Area Council (YTV) that is developing climate change adaptation strategies for the Helsinki Metropolitan Area.
- design concrete adaptation measures for different city departments in cross-departmental network. Existing city strategies and programmes are integrated into adaptation work.

Special focus for measures is on urban built area, harbour areas and development plans.

**Difficulties encountered and ways to solve them:** One of the problems encountered by the City of Helsinki is that climate change impacts are very difficult to translate into planning needs. Scenario data and local planning decisions are far from each other in terms of knowledge needs. Moreover, the priority given to climate change is low in comparison to that given to daily operations and more pressing concerns of the Municipality.

**CASE STUDY 8:** **City:** Lyon
**Metropolitan Area:** Greater Lyon Urban Community
**Country:** France

**Number of inhabitants (city area):** 480 660 (2007)
**Number of inhabitants (metropolitan area):** 1 250 000 (2006)

**Strategy at national level:** "Stratégie Nationale d'Adaptation au Changement Climatique", (July 2007), the document is a national strategy document, and not an action plan as such, focusing on mitigation and not adaptation. An action plan is in preparation. In 2009 a document evaluating the cost of climate change impacts and adaptation was published.

**City or regional adaptation strategy:** An adaptation strategy is in preparation. Currently the Local Agenda 21, (updated 2007-2009) provides a formal basis for adaptation actions (Orientation 2, Action 23: "Begin a prospective reflection of climate change impacts on the metropolitan area").
*Lead administrative body of the strategy:* Grand Lyon – Directorate General, Urban Planning Department (responsible for the city's Climate Plan which mainly focuses on mitigation).
*Strategy part of combined mitigation and adaptation strategy?* Yes, as the risk component of climate change has not been evaluated, adaptation currently represents a smaller strategic component included in the more important mitigation strategy and activities. Adaptation is foreseen to remain a component of the wider strategy that focuses primarily on mitigation.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Heat waves / urban heat islands; Intense precipitation, drainage and flash flooding
*Relevant for the region:* River floods; Drought and water efficiency
*Partially covered by adaptation strategy:* Heat waves / urban heat islands; Intense precipitation, drainage and flash flooding; River floods

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Increased health and disease problems; Biodiversity loss; Water quality; Migration
*Partially covered by adaptation strategy:* Biodiversity loss

**Sectoral coverage:** Adaptation actions are integrated in existing strategies.
*Sectors covered:* Soil protection and biodiversity conservation, protection of green spaces; Urban and regional planning; Health; Water resources management; Building and construction

**Key measures:** One aspect that has been most successfully integrated into existing strategies and actions and in which Lyon has specialised through

available expertise, is the management of green spaces in and around Lyon: they provide ecosystem services crucial to climate adaptation (protection against flooding, preservation of water resources, micro-climate regulation), they also provide positive bio-climatic effects by offering refreshment areas, cast shade from trees on buildings and space, Lyon even has a Tree Charter , some vegetal facades provide thermo-isolation and air purification . Biodiversity adaptation is also considered in this context: adapted tree species are being planted in the city, and biodiversity corridors are being maintained.

**Resources:**
*How long did/will it take to develop the strategy?* >2 years, a specific knowledge base and indicators of risk need to be developed.

**Data and information used to develop the strategy:**
*Climate scenarios:* IPCC SRES: A1, A2 (used during the AMICA research Project (2005-2007))
*Climate models:* developed by "Météo France" and "Institut Pierre-Simon Laplace"
*Climate change vulnerability and impact/risk assessments*: A national assessment (carried out by the ONERC – National Observatory of Climate Change Effects) of the cost of climate change impacts and adaptation was published in September 2009, no risk assessment.

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* The process of developing the strategy, in the LA21
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy?* Other directorates: water, transport.

**Case study comments**

**General background:** Lyon's approach to climate adaptation has not followed a clear and chronological process of strategy development and implementation. The involvement in the AMICA research project (see Annex 2) triggered awareness of the relevance of climate adaptation for the region and offered a first diagnosis of the main adaptation challenges. One output for Lyon was a first and non-quantitative assessment of flood risk, groundwater resources availability and high temperature risk. A realistic and quantitative assessment of the scope and form of risks entailed by climate change for the Lyon region is still lacking.

Following the AMICA process, adaptation objectives have been integrated to existing schemes and strategies. Lyon's Local Agenda 21 mentions two strategic objectives related to adaptation from 2008 on: increase understanding of climate change consequences; and implement concrete adaptation actions. In relation to

the former, two studies are foreseen: a regional study on heat islands led by the DRASS (Regional Directorate on Sanitary and Social Affairs of the Rhône-Alpes region), and a study on risks related to surface runoff.

**Multilevel cooperation and integration with other strategies/policies:** Concrete actions have been integrated to the implementation of urban and regional planning, especially regarding green spaces in and around the city. Other sectors which have integrated adaptation aspects, though often indirectly, are water services and water resource management (influenced by the EU Water supply and sanitation Technology Platform - WssTP), construction, and the city's heat wave plan. A Territorial Coherence Scheme (SCOT) is currently being submitted to a public consultation process and should be approved by the end of 2010. This strategic document will serve as a basis for the development of sectoral planning. Various aspects of the SCOT reflect, not always explicitly, an integrated approach to climate change adaptation through regional and urban planning.

**Difficulties encountered and ways to solve them:** The experience and knowledge gained through "pilot" adaptation actions and strategies provides experience and practice for the elaboration of a future strategy document. However, currently the political interest in climate adaptation is not very high as climate change impacts do not create a specific and measurable economic threat for the greater Lyon region. Since the summer of 2003 the health and sanitary risks entailed by high temperatures especially in cities have been acknowledged and regional emergency heat wave measures (at the department level) can be called into action by the department prefect. This is based on an overall national heat wave plan[18]. However these plans are not put in direct relation with climate adaptation efforts. The main technical challenge in the process of developing a comprehensive adaptation strategy, as identified by our interviewee, is the need for more specific and locally adapted indicators of risk. This type of information would enable a prioritisation and scoping of adaptation actions. For the moment, the available data provided at national level do not fulfil the local and practical information needs related to risk and vulnerability.

In May 2010 a local climate assembly (Conférence Locale Climat) was established in the form of a dialogue and consultation process bringing together 200 public and private socio-economic stakeholders. In this framework and beside several working groups on emission reduction issues (per sector and cross-cutting), a working group on climate adaptation was created.

[18] Plan National Canicule

**CASE STUDY 9:** **City:** City of Bremen
**Metropolitan Area:** Bremen Oldenburg
**Country:** Germany

**Number of inhabitants (city):** 547 360 (2008)
**Number of inhabitants (metropolitan area):** 2 367 950 (2008)

**Strategy at national level:** German Strategy for Adaptation to Climate Change (adopted by the Federal Cabinet on 17 December 2008)

**City or regional adaptation strategy:** "Northwest2050 - Prospects for Climate-Adapted Innovation Processes in the Model Region Bremen-Oldenburg in North-Western Germany", which represents one of the seven projects funded by the Federal Ministry for Education and Research in the context of the KLIMZUG funding activity (see Annex 2). Northwest2050 started developing in 2009 and it is scheduled to be finalised by 2014; as can be gathered by its name, the project's future orientation goes well beyond this five-year duration.

*Lead administrative body of the strategy:* The "Metropolitan Region Bremen-Oldenburg in the North-West"; the title is a recognition of the region's economic importance in international trade and helps to enable coordinated business development within the Metropole Northwest.

*Strategy part of combined mitigation and adaptation strategy?* The project focuses mostly on adaptation; the development of such a strategy was indeed one of the main co-criteria for it to be funded by the above-mentioned Ministry. Mitigation represents just a side aspect of the overall research and a small working group focuses on combining the two aspects together; their work is quite important since the area of mitigation is better known and easier to communicate (especially on the results' side in the business sector, e.g. saving energy costs), while adaptation is harder to be "promoted", since its results are going to be felt in the more distant future (20-30 years).

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* sea level rise, wind/storm damage;
*Relevant for the region:* river floods, intense precipitation, drainage and flash flooding, heat waves;
*Partially covered by adaptation strategy:* Sea level rise, intense precipitation, drainage and flash flooding, drought and water efficiency, heat waves and urban heat islands, river floods, wind/storm damage;

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* water quality;
*Partially covered by adaptation strategy:* Increased health and disease problems

**Sectoral coverage**
*Sectors covered:* Urban and regional planning; Transport, Energy supply and consumption; Regional/Local economy; Agriculture and Food industry.
Main goal of the strategy is indeed to define the vulnerability of economic sectors for the *food industry*, the *energy production*, the *port management and logistics*. The activity will focus for example on resilient food plants, environmentally friendly cooling and air conditioning technologies as well as the capacity of electricity grid.

**Key measures:**
The research project, which will last for the next four years, is still at its beginning stage. There are therefore no existing experiences in developing and implementing defined policies and measures either in the governance field or in communication activities. This last aspect is considered the biggest success factor; communicating the problems faced and addressed by the research, its future results, and getting stakeholders' (business sector; political/administrative institutions; civil society) attention and involvement is and will be one major key issue. The considered key measure would in that case be represented by a target-group oriented communication strategy.

**Resources:**
*How long did/will it take to develop the strategy?* >2 years
*Resources used to develop the strategy*: financial→ the budget amount is EUR 11.6 million, out of which EUR 9.9 comes as a subsidy from the Federal Ministry for Education and Research and the rest planned to be added by the business sector once the measures are about to be implemented;
personnel→ about 45 people (approx. 25 full-time) directly involved in the 6 research organisations part of the Project Consortium (approximately 10 other research institutions are cooperating with the main ones); about 40 people from the business sector; 3-4 employees from the central office of the Metropolitan area; an Advice Body, composed of 10-12 key people from the region and embracing all relevant sectors (e.g. Agriculture, Industry), will be set up in August, in order to "open the doors" of the different regional institutions and political bodies.

**Data and information used to develop the strategy:**
*Climate scenarios:* the research partner Bio Consult is working on adapting the global scenarios of $CO_2$ emission impacts developed by IPCC (A1B, A2, B1), in order to determine the influence of different climate change parameters (e.g. temperature, sea level, wind) on the areas targeted by the project.
*Climate models:* CLM, REMO, Wettreg; with regional modelling concepts, cooperation with the Climate Change Services in Hamburg at Max Planck Institute for Meteorology;
*Climate change vulnerability and impact/risk assessments:* Region specific.

**Involvement in strategy development and implementation:**
*Research institutions*: (the six institutions part of the consortium)

1. Metropolitan Region Bremen-Oldenburg in the Northwest e.V.;
2. University of Bremen, Research Centre for Sustainability Studies;
3. Econtur gGmbH (Sustainability Centre Bremen);
4. Centos - Oldenburg Centre for Sustainable Economics and Management, University of Oldenburg;
5. University of Applied Sciences Bremen;
6. BioConsult Schuchardt & Scholle GbR;

*Private organisations*: about 20 enterprises (and several business associations as well (including, for example, the Chamber of Commerce);
*Participation of administrative bodies*: several cities which are part of the metropolitan area (other than Bremen and Oldenburg), have committed their support.

## Case study comments

**Motivation and priorities for strategy development:** With this practice-oriented research project, the Northwest German region is among the selected model regions in Germany that – through the support of the KLIMZUG programme – has the opportunity to develop improvements in their ability to deal with climate change in selected fields, and to integrate them into regional planning and development processes. The main goals pursued by "Northwest 2050" are at least two:
1. To define the vulnerability of economic sectors for the food industry, energy production and distribution, and port management and logistics, evaluate chances for innovation and implement concrete measures;
2. To measure the potential for innovation and the ability to mobilise; targeted are not only technical innovations at different stages of development (e.g. solar cooling systems, low exergy solutions, resilient logistics systems, adapted cultivation und processing strategies in the food industry), but also organisational and institutional innovations (e.g. management of regional climate impacts, adaptive governance, land use management, risk communication, capacity building).

It appears clear, then, that developing the ability to adapt and innovate is important, but this has to be done together with enterprises' practitioners, in order to secure the ability to implement adaptation options.

**CASE STUDY 10:** **City:** City of Dresden
**Metropolitan Area:** REGKLAM Model Region Dresden
**Country:** Germany

**Number of inhabitants (city):** 507 513 (2007)
**Number of inhabitants (metropolitan area):** 1 285 143 (2007)

**Strategy at national level:** Deutsche Anpassungsstrategie (2008), Action Plan on Adaptation to be published 03/2011

**City or regional adaptation strategy:** Integrated Regional Climate Adaptation Programme for the Model Region of Dresden (draft in 12/2010; final in 2013)
*Lead administrative body of the strategy:* Research project coordinated by the Leibniz Institute of Ecological and Regional Development (IÖR); the City of Dresden's Environmental Office co-ordinates regional actors within the project.
*Strategy part of combined mitigation and adaptation strategy?* No.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* River floods; Intense precipitation, drainage & flash flooding; Drought and Water efficiency; Heat waves / urban heat islands
*Relevant for the region:* Wind / storm damage
*Covered by adaptation strategy:* Intense precipitation, drainage and flash flooding; Drought and water efficiency; Heat waves / urban heat islands
*Partially covered by adaptation strategy:* River floods; Wind / storm damage

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality; Increased health and disease problems; Biodiversity loss
*Covered by adaptation strategy:* Water quality
*Partially covered by adaptation strategy:* Increased health and disease problems; Biodiversity loss

**Sectoral coverage:**
Comprehensive, cross-sectoral adaptation strategy
*Sectors covered:* Air quality; Health; Flood and coastal zone management; Water resources management; Soil protection and biodiversity conservation, protection of green spaces; Urban and regional planning; Building and construction; Energy supply and consumption; Regional/Local economy; Tourism and leisure activities; Urban development, land use management

**Key measures[19]:**
No. 1 – complete water balance in the region including water supply, waste water treatment, flood protection and changes in groundwater

[19] Key measures of the adaptation programme are not finally defined yet; mentioned here are the main areas of research in the REGKLAM project

No. 2 – city development including reconstruction and development of the "ecological net"; including development of infrastructure (energy supply, water etc.) following the guideline "compact city in the ecological net"
No. 3 – managing land use (especially in case of conflicting interests between agriculture, forestry, flood protection, nature protection, settlements, protection of water resources etc.)

**Resources:**
*How long did/will it take to develop the strategy?* >2 years
*Resources used to develop the strategy* (REGKLAM project): Financial – 11,000,000 EUR (research budget); Personnel – REGKLAM finances one full-time and two half-time positions in the Dresden Environmental Office for five years, and one half-time position for one year. In total, about 100 people work more or less directly on the project; External support – financed by the Federal Ministry of Education and Research
*Resources used to implement the strategy:* Financial – administrative budget; Personnel – existing; External support – additional programmes and projects

**Data and information used to develop the strategy:**
*Climate scenarios:* IPCC SRES: A1B, A2, B1. Existing climate scenario data broken down to the regional level and combined with socio-economic scenarios, e.g. on demographic change
*Climate models:* CLM, REMO, WETTREG, WEREX IV; downscaled into the region and additional analysis, e.g. on atmospheric chemistry
*Climate change vulnerability and impact/risk assessments:* Region specific (part of research activities on each sector addressed in REGKLAM)

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* Strategy development process
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy?* all departments of the city administration, and from the Land of Saxony
*...implementation of the strategy?* in progress
*Stakeholders involved in strategy development:*
*Private organisations:* private companies, green space offices, engineering companies, energy and water suppliersetc.
*Research institutions:* Leibniz Institute of Ecological and Regional Development, Technical Universities of Dresden and Freiberg, Inst. for Tropospheric Research, Groundwater Research Centre
*NGOs and/or citizens' initiatives:* Local agenda 21, local initiatives and discussion groups, lobby groups
*Governments of neighbouring cities/regions:* Cities and district administrations of the region, *Regionaler Plannungsverband Oberes Elbtal/Osterzgebirge* (Regional planning alliance for this sub-region of Saxony)

## Case study comments

**Leadership, stakeholder integration and public consultation:** REGKLAM is a research project with prominent involvement of municipal and regional administrative bodies. While IÖR is responsible for the overall project co-ordination, the city of Dresden coordinates regional partner activities. This is because formal cooperation between regional administrative bodies and municipalities is complex and challenging from a legal point of view (German municipal / administrative law). The city of Dresden takes part in the consortium as a representative of all involved regional municipalities. The *Regionaler Planungsverband* (regional planning alliance) is an associated consortium member.

**Motivation and priorities for strategy development:** A city council decision acknowledging the relevance of adaptation to climate change was made in 2004, but it did not lead to concrete activity until 2007, when the KLIMZUG programme (see Annex 2) was launched by the German Ministry of Research and Education. This triggered cooperation between the city of Dresden and the research institutions that are now involved in the REGKLAM project. Synergies with other / upcoming projects are actively sought. For instance, the *Regionaler Planungsverband* is also leading one of eight regional model projects within the funding activity "Spatial Development Strategies for Climate Change" (www.klimamoro.de) of the German Federal Ministry of Transport, Building and Urban Development.

**Multilevel cooperation and integration with other strategies/policies:** Dresden has an Integrated Urban Development Concept (INSEK) which serves as an informal planning instrument (last updated in 2006). The INSEK refers to sectoral issues related to climate change and adaptation (e.g., urban climate or groundwater management) although the connections are not clear. REGKLAM will provide an enhanced scientific foundation for relating planning to climate change. It is not yet clear how this will be integrated later into INSEK or into formal planning tools such as *Flächennutzungsplan* and *Bebauungsplan*. The Environmental Office of Dresden favours integrating adaptation measures in existing planning tools rather than creating new instruments. Similarly, existing networks and cooperation structures at various administrative levels should be used rather than creating new institutional structures.

Dresden became a member of the "Climate Alliance of European Cities with the Indigenous Rainforest Peoples" in 1994. Based on its membership obligations, a "Framework programme on $CO_2$ reduction" was decided in 1998 and progress has been regularly reported, most recently in 2008. While REGKLAM focuses on adaptation and will not directly contribute to the $CO_2$ reduction programme, the city administration considers consistency between mitigation and adaptation strategies to be important. Both strategies will have to be implemented by

concrete planning measures, which should aim for synergies between the two objectives or at the very least avoid conflicts.

The preparation of Integrated Regional Climate Adaptation Programme, a key REGKLAM objective, requires the integration of existing sectoral approaches to adaptation (such as the municipal flood management concept or the Federal State of Saxony's adaptation strategy for the agricultural sector) and the different components of the REGKLAM project (such as urban planning, water management and land use management) into one consistent strategy. This is also a lesson learnt from other cities: it is crucial to develop integrated concepts in order to avoid conflicts and inefficiency at the implementation level.

**Difficulties encountered and ways to solve them:** It is too early to foresee possible problems within the REGKLAM project and its associated federal-level funding will end in 2013. It needs to be emphasised that the research project not only serves the development of an adaptation programme, but also includes an initial implementation phase. In the long run, it remains to be seen whether additional personnel resources (in terms of additional staff) will be needed to continue work on adaptation issues. It is also possible that other measures, such as additional training for existing staff, will turn out to be the better solution.

Lack of data and uncertainty of predictions constitute challenges for the adaptation process. The REGKLAM research project helps to address these challenges. Other challenges may occur later on but little can be said on this matter now: e.g. when political and planning decisions will be made, and in cases for which there are conflicting land-use interests – will these decisions be made from a long-term perspective or will short-term considerations prevail? Decisions on the allocation of financial resources may also be associated with problems. Another question is whether public awareness of climate change impacts will be high enough to enable support for adaptation measures. Public awareness measures have not been the focus of project activities so far.

**CASE STUDY 11:** **City:** Hamburg
**Metropolitan Area:** Hamburg
**Country:** Germany

**Number of inhabitants (city):** 1 772 100 (2008)
**Number of inhabitants (metropolitan area):** 4,286,123 (2008)

**Strategy at national level:** Deutsche Anpassungsstrategie (12/2008)

**City or regional adaptation strategy:** Hamburger Strategie zur Anpassung an den Klimawandel (expected for 12/2010)
*Lead administrative body of the strategy:* Behörde für Stadtentwicklung und Umwelt
*Strategy part of combined mitigation and adaptation strategy?* Adaptation is already part of the existing climate strategy document but a separate adaptation strategy is in preparation.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Sea level rise (most relevant as in the long run it threatens the existence of the city – the other topics may require more immediate action)
*Relevant for the region:* River floods; Intense precipitation, drainage and flash flooding; Drought and water efficiency; Heat waves / urban heat islands; Wind / storm damage
*Covered by adaptation strategy:* River floods; Intense precipitation, drainage and flash flooding; Drought and Water efficiency; Heat waves / urban heat islands[20]
*Partially covered by adaptation strategy:* Wind / storm damage

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality; Increased health and disease problems; Biodiversity loss; Migration, differential social impacts
*Covered by adaptation strategy:* All of the above

**Sectoral coverage:**
Comprehensive, cross-sectoral adaptation strategy
*Sectors covered:* Health; Flood and coastal zone management; Water resources management; Soil protection and biodiversity conservation, protection of green spaces; Waste management; Urban and regional planning; Building and construction; Emergency planning

[20] Indications on coverage of climate change impacts and sectors are only preliminary since the adaptation strategy is still under preparation and has yet to be passed by the Senate.

**Key measures[21]:**
No. 1 – Coastal protection will have to be diversified: not only dams and dykes, but other measures like artificial islands, retention areas, moveable dyke constructions, private initiatives etc
No. 2 – Construction activities will have to take into account a rising water level
No. 3 – Construction activities and city development will have to leave room for thermal cooling where necessary

**Resources:**
*How long did/will it take to develop the strategy?* >1 <2 years
*Resources used to develop the strategy*: Financial – So far, ca. EUR 100 000 Euro – the greatest part of it for research. Additional contribution of ca. 2 million by the city of Hamburg to the 5-year "KLIMZUG Nord" research project; Personnel – 1 person almost full time in the city administration; sporadic contributions from all relevant sectors; External support – use of external moderators to facilitate consultation workshops
*Resources used to implement the strategy:* Financial – not known; Personnel – 1 person; External support – Scientific support expected from the German Federal Environment Agency (UBA)

**Data and information used to develop the strategy:**
*Climate scenarios:* A study by UBA developed regional scenarios on the basis of model data that took into account IPCC SRES scenarios A1B, A2, B1, B2.
*Climate models:* Miscellaneous. The UBA study used data from the German regional climate models REMO, COSMO-CLM, RCAO, WettReg and STAR.
*Climate change vulnerability and impact/risk assessments:* Region specific (part of the UBA study)

**Involvement in strategy development and implementation**
*Binding political commitment exists regarding:* Strategy development
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy?* All of them, at least as far as concerned.
*...implementation of the strategy?* All of them, at least as far as concerned.
*Stakeholders involved in strategy development:*
*Private organisations:* Mainly state-owned enterprises involved.
*Research institutions:* Many research organisations located in or around Hamburg (e.g. Max-Planck-Institute, universities) have been involved.
*NGOs and/or citizens' initiatives:* Involvement just starting
*Governments of neighbouring cities/regions:* They are part of the KLIMZUG-Nord research project.

[21] The denomination of key measures within the strategy reflects purely a personal opinion, not an official prioritisation.

## Case study comments

**Motivation and priorities for strategy development:** Hamburg is both a city and a Federal State. In addition to adaptation strategy development for the city state of Hamburg, the Hamburg Metropolitan Region (i.e. Hamburg with the surrounding *Länder* of Schleswig-Holstein and Lower Saxony) is also an important player. The KLIMZUG-Nord project, which is funded as part of the federal KLIMZUG programme (see Annex 2), refers to the metropolitan area. By 2014, it aims to prepare (or at least scientifically support) a master plan for climate change management in this region addressing a time horizon up to 2050. Although there is a close interaction between the research-driven project for the metropolitan region and the administration-driven strategy development for the city of Hamburg, these are separate developments. Unlike the Dresden example, the local administration is not a beneficiary of federal adaptation research funds, but has instead contributed significant funds to the regional KLIMZUG project.

**Multi-level cooperation and integration with other strategies/policies:** Action on adaptation ("Climate consequence management") was included in Hamburg's "Climate Action Policy 2007-2012" from the beginning; only the 2008 update provided a mandate to develop a stand-alone adaptation strategy document, to be completed by the end of 2010. Mitigation and adaptation strategies will remain linked to each other, but it is not clear in which way. In addition, Hamburg is preparing a sustainable development strategy which may serve as an umbrella for both mitigation and adaptation activities. It cannot yet be said to what extent this umbrella function will increase policy integration in a practical sense. In terms of external support, the German Federal Environment Agency (UBA) has played the most important role. A major part of Hamburg's adaptation budget was spent on a scientific "framework for orientation" prepared by UBA which broke down regional climate models for Northern Germany and structured the data into three scenarios: optimistic, intermediate and pessimistic. In a second step, it proposed two scenarios (intermediate and pessimistic) that describe regional climate change by 2050 and 2100. UBA also acts as a facilitator of expert dialogues on adaptation and is expected to provide substantial scientific guidance for future climate and emissions monitoring.

**Leadership, stakeholder integration and public consultation:** The leading authority for adaptation strategy development secured political commitment, built networks and received scientific support early in the process. In terms of stakeholder participation, two workshops have been conducted so far, both for public authorities and for state-owned enterprises. Consulting the general public has been postponed until after the strategy will have passed the Senate. The adaptation strategy development process confronted problems like budget cuts following financial shortcuts because of other priorities set.

**CASE STUDY 12:** **City:** City of Budapest
**Country:** Hungary

**Number of inhabitants (city):** 2 500 000 (2008)

**Strategy at national level:** The Hungarian National Climate Strategy for 2008-2025 was adopted in 2008. Within this strategy a 'Climate-Preventive Health Strategy' was drawn up. However, the 'Climate-Preventive Health Strategy' has incorporated the already existing Heat Alert (HA) system which had been developed and adopted in 2007 in the framework of the EuroHeat Programme.

**City or regional adaptation strategy:** There is no single comprehensive adaptation strategy for the city of Budapest. However, a number of legal documents stipulate protection measures against the incidents associated with climate change. For instance, for the case of the heat waves, there is a so-called Heat Alert System – a number of protocols of actions for the stakeholders. The other health protection systems are so-called Smog Alert and UVA Alert systems. They deal with the health problems which can be indirectly exacerbated by climate change.

*Strategy part of combined mitigation and adaptation strategy?* No

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Heat waves / urban heat islands, river floods
*Relevant for the region:* River floods, intense precipitation, Drainage and flash flooding; Drought and water efficiency; Wind damage
*Covered by adaptation strategy:* Heat waves / urban heat islands

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Increased health problems (heart and respiratory complaints, premature births); Biodiversity loss, Water Quality, Air Quality
*Covered by adaptation strategy:* Increased health problems

**Sectoral coverage:**
*Sectors covered:* Health, Air Quality, Transportation, and all those which require outdoor activities.

**Key measures:**
No 1 – Heat Alert system. It is a system launching the protocols of actions under the heat wave regime. At the first level of the HA only the National Public Health and Medical Officers' Service is informed via fax and email The local governments along with the health institutions, the emergency ambulance service and population are informed starting with the second level of heat alert. The general public is informed through the mass media, and other stakeholders via fax and email.

No 2- Restrictions on road traffic. Cars with odd and even number plates should stay at home every two days. This measure is launched during the Smog Alert. However, combined with the HA, the restriction prevents additional urban heating from transport and worsened air pollution.

**Resources:**
*How long did/will it take to develop the strategy?* About a year
*Resources used to develop the strategy:* No information disclosed
*Resources used to implement the strategy:* No information disclosed

**Data and information used to develop the strategy:**
*Climate scenarios:* The IPCC SRES were used based on the Third Assessment Report (TAR), Climate Scenarios for the Hungarian National Climate Strategy for 2008-2025, developed by the Hungarian Meteorological Service, 2006.
*Climate models:* The outcome of the global climate models were used as boundary conditions for the running the LAM (Limited Area Model) for Hungary. In the framework of the PRUDENCE project several regional models were run and then averaged to estimate the spatial distribution of future climate parameters for Hungary. Horizontal resolution was 50 km.

*Climate change vulnerability and impact/risk assessments:* No
The experiences of other big European cities have been studied, especially the experience of Paris, France.

**Involvement in strategy development and implementation:**
*Participation of administrative bodies / departments, other than the lead administrative body, in the .development of the strategy?*
Ministry of Economy and Traffic, Ministry of Social and Labour Affaires, Ministry of Health,

*...implementation of the strategy?* National Head Office of Catastrophe Prevention, National Emergency Ambulance Service, National Chief Inspectorate for Labour and Labour Safety (OMMF), Police Headquarters, Road Information 'Útinform', Motorway Police Headquarters

*Stakeholders involved in strategy development:*

*Private organisations:* Association of Private Entrepreneurs and International Transport Companies, Association of Hungarian Truck Companies,

*Research institutions:* National Meteorological Service, National Institute for Environmental Health (NIEH)

*NGOs and/or citizens' initiatives:* Red Cross HQ (Hungary)

*Governments of neighbouring cities/regions:* They have been involved later to learn the lessons from Budapest

## Case study comments

**General background:** The city of Budapest has not yet developed a comprehensive adaptation strategy. To combat both direct and indirect consequences of the heat waves, the city of Budapest has developed the Heat Alert System, UVA Alert System, and Smog Alert System. The principles of the HA were first developed for Budapest and then for the whole country. Budapest is the first city where HA of the third level was declared in July 2007, and the protocols of actions have been tested. The HA is declared in Budapest by the Mayor based on communication from the NIEH on the 3-day temperature forecast. If the daily average exceeds 25 degrees for 1 day for Budapest it is HA of the first level, 27 degrees trigger second level alert, and 27 degrees for the next 3 days launch the third level HA.

In Budapest under the HA of second and third levels, special action plans are developed for the health institutions including high preparedness for the increased number of patients with heart ailments and women giving birth prematurely. In Budapest the number of ambulance cars on duty for one shift is also increased by approximately one third. The information on the Heat Alert is distributed within the blocks of news through the national media channels and local ones. Advice on how to protect oneself and other people are given in special short (5-10 mins long) broadcastings.

The municipality of Budapest undertakes the following actions during the HA: provides information on the affordable and efficient protection measures, location of the publicly accessible air-conditioned buildings (for instance, shopping malls) and recreational areas, ensures that the supply of drinking water in the public institutions and at working places is adequate, distributes drinking water in streets with a high number of tourists, enforces the efficient use of water (private car washing and garden sprinkling is forbidden), encourages businesses owning swimming facilities to lower entrance fees at least for the most vulnerable groups. During the July 2007 Heat Alert the temporary bus routes towards the swimming locations were provided free of charge.

Several districts of Budapest have information on the Heat Alert and means of protection on their websites as well. The Smog Alert has not been designed to combat heat waves. However, combined with HA, it combats the indirect consequences of heat waves. Cars with odd number plates can drive one day, the next day is for cars with even plate numbers. Through the traffic restrictions it can both decrease urban heating and emissions of air pollutants from transport as well as the respiratory problems of the population.

**CASE STUDY 13:** **City:** City of Tatabánya
**Country:** Hungary

**Number of inhabitants (city):** 70 541 ( 2007)

**Strategy at national level:** Yes (2008)

**City or regional adaptation strategy:** The Local Climate Change Strategy and Action Plan of Tatabánya (2008)
*Strategy part of combined mitigation and adaptation strategy?* The strategy includes both mitigation and adaptation.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Heat waves / urban heat islands
*Relevant for the region:* Intense precipitation, drainage and flash flooding; Drought and Water efficiency; Wind damage, Wild fires
*Covered by adaptation strategy:* Heat waves / urban heat islands, Intense precipitation, drainage and flash flooding; Wild Fires, Drought and Water efficiency; Wind damage,

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Public health problems; Biodiversity loss, Water Quality
*Covered by adaptation strategy:* Public health problems; Biodiversity loss

**Sectoral coverage:**
Comprehensive, cross-sectoral adaptation strategy
*Sectors covered:* Air quality; Health; Water resources management; Building and Construction, Energy supply and consumption, Biodiversity preservation

**Key measures:**
No 1 – System of Heat and high UVA Alerts: system to launch the protocol of actions under heat and/or UVA alert regimes and to inform the general public on measures to protect themselves against high temperature
No 2- Smart Sun Educational Programme
No 3- Increasing capacity of fire brigades to fight wild fires

**Resources:**
*How long did/will it take to develop the strategy?* Approx. 1.5 years
*Resources used to develop the strategy*
Financial - Development of Strategy and Action Plan was made by utilising the budget for Environmental Education and Climate Change on the municipal level; Personnel - staff from the Municipality of Tatabánya; External support – staff from Sociological Research Institute of the Hungarian Academy of Sciences.

*Resources used to implement the strategy:* The Local Climate Change Action Plan states that the budget of the municipality has to be planned in a "climate friendly" way and climate objectives have to be considered. The aim is to establish a separate climate budget line. For 2009 the budget for implementation was HUF 4 000 000 (approx. EUR 20 000) and one full-time climate manager.

**Data and information used to develop the strategy:**
*Climate scenarios:* The IPCC SRES were used based on the Third Assessment Report (TAR), Climate Scenarios for the Hungarian National Climate Strategy for 2008-2025, developed by the Hungarian Meteorological Service, 2006
*Climate models:* The outcome of the global climate models were used as boundary conditions for the running the LAM (Limited Area Model) for Hungary. In the framework of PRUDENCE project several regional models were run and then averaged to estimate the spatial distribution of future climate parameters for Hungary. Horizontal resolution was 50 km.
*Climate change vulnerability and impact/risk assessments:* No. The experience of other European cities was studied.

**Involvement in strategy development and implementation:**
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy? Yes*
*...implementation of the strategy?* Local police, local ambulance service, local civil defense, local fire department, local disaster recovery, schools, nurseries, local hospital, National Public Health Institute.
*Stakeholders involved in strategy development:*
*Research institutions:* Sociological Research Institute of the Hungarian Academy of Sciences
*NGOs and/or citizens' initiatives:* The National Alliance of Climate-friendly Cities, public utility companies, public institutions, engineers, teachers, civil servants, students
*Governments of neighbouring cities/regions:* They were informed.

## Case study comments

**General background:** The National Climate Change Strategy of Hungary adopted in 2008 encourages the creation of regional and local climate action strategies and plans. The National Strategy represents a framework for the period 2008-2025 for both mitigation and adaptation. Concrete measures/activities are identified for the first two years, after that a revision is expected.

**Multi-level cooperation and integration with other strategies/policies:** Development of the Local Climate Change Action Plan of Tatabánya (hereinafter Plan) is a specific case of governance where the bottom-up and top-

down approaches meet each other. It is intended to be a model for all Hungarian large and small cities. This local Plan also considers an integrated approach addressing both mitigation and adaptation. The main characteristic of the Plan is that it incorporates climate considerations into the decision making. At any budget hearing or public procurement discussions the climate proof-check should be performed.

**Motivation and priorities for strategy development:** The key adaptation challenges have been identified as: heat waves, extreme precipitation, and wild fires.

**Leadership, stakeholder integration and public consultation:** The Department for Strategy and Control (Municipality of the County Level City of Tatabánya) has been the lead governmental body during preparation of the Plan, and it is prepared now to be the leading implementing agency. The plan was prepared with the assistance of the Sociological Research Institute of the Hungarian Academy of Sciences. The municipality of the County Level City of Tatabanya has been supporting the initiatives proposed by the Academy and, by using the support of civil society, the problems of environmental protection and specifically climate change were adressed. (Tatabánya is a member of ICLEI and the Cities for Climate Protection campaign). The National Alliance of Climate-friendly Cities was formed by Tatabánya in 2008. In 2008 the Plan was adopted, and the first implementation steps started.

The implementation of the Climate Action Plan is ongoing, and the management of the municipality is regularly informed about its state of progress and its elements are/will be considered during the preparation/revision of long-term spatial plans. The Plan declares that climate objectives have to be considered when public procurements are carried out and when future local development plans are drafted.

During the preparation of the Plan extensive stakeholder consultations took place: all relevant municipal bodies (for instance, the department of education within the Municipality of Tatabánya), schools, nursery homes, utility providers (electric company, industrial enterprises, the transport managing company, waste managing companies etc).

**Monitoring and evaluation:** The scientific evidence about future climate change scenarios might change. However, the Plan has a built-in instrument to adjust to new evidence.

**CASE STUDY 14:** **City:** Municipality of Bologna
**Metropolitan Area:** Bologna
**Country:** Italy

**Number of inhabitants (city):** 378 617 (2010)
**Number of inhabitants (metropolitan area):** 976 175 (2010)

**Strategy at national level:** Does not exist.

**City or regional adaptation strategy:** Spatial planning strategy. A Local Climate Plan addressing adaptation and mitigation will start to be elaborated in 2010.

*Lead administrative body of the strategy:* Municipality of Bologna.

*Strategy part of combined mitigation and adaptation strategy?* Yes

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* river floods, intense precipitation, drainage and flash flooding, Drought and water efficiency
*Relevant for the region:* sea level rise, Heat waves / urban heat islands
*Partially covered by adaptation strategy:* Intense precipitation, drainage and flash flooding; Heat waves / urban heat islands, River floods, Drought and water efficiency

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality, biodiversity loss, increased health and disease problems

**Sectoral coverage:**
Sector-specific adaptation strategy (Local Climate Plan, to be developed in the future).
*Sectors covered:* Air quality; Health; Water resource management, urban and regional planning, building and construction, energy supply and consumption, emergency planning.

**Key measures:**
No. 1: WATER: Reduce erosive impact of rainwater on local rivers, by building a basin from which water drains to rivers at a more or less steady pace. New buildings are already required to build a vessel where rainwater is kept and discharged to the network steadily).
No. 2 – WATER: Promote the reduced consumption of water by the population, by raising awareness. Together with measures such as recycling rainwater, etc.

No. 3 – URBAN MICROCLIMATE: The new building code (implemented since 2009) requires the use of green elements in buildings, such as grass planted in roofs, avoidance of dark colours, in order to decrease the negative impacts of very high summer temperatures in the city. (This measure has caused considerable controversy).

**Resources:**
*How long did/will it take to develop the strategy?* > expected to take two years (but as the political situation is fluid at present may take longer).
*Resources used to develop the strategy:* Strategy has not yet been developed (For implementation of specific projects see individual adaptation measures).

*Resources used to implement the strategy:* Not relevant as there is no strategy to implement.

**Data and information used to develop the strategy:**
*Climate scenarios:* Regionally adapted, based on very local forecasts will be used when the strategy is developed.
*Climate models:* None yet.
*climate change vulnerability and impact/risk assessments:* No.

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* Developing the spatial planning strategy (in the past). No commitment yet for the adaptation/mitigation Local Climate Plan.
*Participation of administrative bodies / departments, other than the lead administrative body, in the .development of the strategy?* Universities, organisation of engineers/architects, other cities.
*implementation of the strategy?* Yes, but information not available.
*Stakeholders involved in strategy development:*
*Private organisations:* Yes, but information is not available.
*Research institutions:* Yes, but information is not available.
*NGOs and/or citizens' initiatives:* Yes, but information is not available.
*Governments of neighbouring cities/regions:* Yes they will be involved when the strategy is developed.

## Case study comments

**General background:** The Municipality of Bologna has no adaptation strategy. Neither does Italy at a national level. Bologna developed a spatial planning strategy recently; a highlight being the new building code, including green measures. Now the city wants to develop a Local Climate Plan covering adaptation and mitigation (an adaptation/mitigation strategy). It was expected that the organisation chart of the LCP team would be announced in May 2010.

**Motivation and priorities for strategy development:** Even so the Municipality is already implementing the three key measures which it considers most important to combat climate change. Water management and sustainable use of this resource are critical, as the region has recently experienced floods and longer drought seasons (same amount of rain but concentrated in shorter times). The other priority is to deal with rising temperatures.

**Difficulties encountered and ways to solve them:** Complicated local political situations, with the Lord Mayor resigning his position earlier this year have made political commitment a clear obstacle in forward developing strategies. Elections in Bologna have not yet been announced, but they may be either in autumn 2010 or spring 2011. As a footnote, even though Bologna signed the Covenant of Mayors in December 2008 it has not yet prepared a SEAP (Sustainable Energy Action Plan). Political turbulence has been an important factor in this inability to set clear directions and targets.

**CASE STUDY 15:** **City:** City of Venice
**Country:** Italy

**Number of inhabitants (city):** 271 009 (2009)

**Strategy at national level:** In preparation but no target date announced.

**City or regional adaptation strategy:** There is no overarching climate change mitigation and/or adaptation strategy. Several adaptation projects are ongoing, mainly related to water management.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* sea level rise, intense precipitation, drainage and flash flooding (only mainland Venice)
*Relevant for the region:* river floods, wind/storm damage, heat waves/urban heat islands
*Covered by adaptation strategy:* N/A.

**Key adaptation challenges from *indirect* climate change impacts:**
*Most relevant for the city:* biodiversity loss, migration, differential social impacts, economic impacts of extreme high tide events on commercial activities, economic impact of city maintenance interventions needed (raising ground floors, reinforcing canal sides and foundations of houses etc.)
*Relevant for the city:* increased health problems
*Covered by adaptation strategy:* n/a

**Sectoral coverage:**
Existing measures deal mostly with water-related concerns and activities.

**Measures that Venice has carried out /is carrying out which can contribute to the City´s adaptation to climate change:**

1. City of Venice Tide Centre that provides constant monitoring of sea level and meteorological events, in order to inform and warn the population of predicted high tide.
2. Maintenance activities provided by Insula spa, an urban maintenance company owned by the city of Venice and the four utility companies. The interventions carried out by Insula spa are aimed at protecting the city from flooding (e.g. raising the margins of islands and canals, raising urban surfaces).

It should be noted that these are not necessarily the most important measures to be included in the future adaptation strategy.

## Case study comments

**General background:** The City of Venice has not yet developed an adaptation strategy. Involvement in European projects has brought the expertise needed but so far the measures implemented have not been part of a strategic policy process.

In 2005-2007 the City of Venice participated as a partner in the AMICA project (see Annex 2). The project aimed to demonstrate a variety of measures taken by local governments for climate protection and identify short to medium-term policies. The results of the projects could have been used as a starting point to develop an adaptation strategy but there has been no follow-up so far.

Despite the lack of adaptation strategy, Venice has a lot of experience in implementing measures related to sea level rise and flooding that could be very relevant for other coastal cities, confronted with similar problems.

**CASE STUDY 16:** **City:** City of Riga
**Country:** Latvia

**Number of inhabitants (city):** 722 485 (2007)
**Number of inhabitants (agglomeration):** 1 500 000

**Strategy at national level:** A report on climate change adaptation was prepared in 2008. Two groups (inter-ministerial and scientific) have been established to elaborate the national adaptation strategy to be completed in 2010.

**City or regional adaptation strategy:** No single comprehensive adaptation strategy for the city of Riga exists. A number of other strategies and legal documents address different aspects of adaptation. Almost all these documents consider only the "nature disasters" without recognizing that these are likely to become more frequent and severe due to climate change.

*Spatial Plan of Riga for 2006-2018* takes the majority of the legal stipulations into consideration, and is considered as the first step towards the development of the local adaptation strategy.

*Strategy part of combined mitigation and adaptation strategy?* No. There is a separate National Climate Change Mitigation Strategy adopted in 2005.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Storm surges, coastal flooding/river flooding, coastal erosion
*Relevant for the region:* groundwater level rise, dam safety, heat waves
*Covered by adaptation strategy:* Storm surges, coastal flooding, river flooding,

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Public health problems; biodiversity loss, water quality, air quality
*Covered by adaptation strategy:* Public health problems

**Sectoral coverage:**
*Sectors covered:* Water, waste, wastewater treatment, energy, transport, social impacts.

**Key measures:**
The following two measures explicitly recognise climate change threats and the need for adaptation:
No 1 – Protective zones/Spatial Plan of Riga for 2006-2010
No 2 - Dunes maintenance along the Riga Bay coastal line in Riga and Jurmala

**Resources:**
*How long did/will it take to develop the strategy?* 2.5 years (2002 - 2005)
*Resources used to develop the strategy:* Riga City Council budget

*Resources used to implement the strategy:* Not possible to identify clearly.

**Data and information used to develop the strategy:**
*Climate scenarios:* In the *Spatial Plan of Riga for 2006-2018* climate change per se is not considered. For the whole country monthly average temperature changes up to 2100 are calculated within the Swedish Regional Climate Modeling Programme (SWECLIM)
*Climate models:* Vulnerability mapping regarding the sea level rise due to storm surges was completed by the Potsdam Institute for Climate Impact Research (PIK) using DIVA model in the framework of the ASTRA (INTERREG III) programme.
*Climate change vulnerability and impact/risk assessments:* No

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* Not applicable.
*Participation of administrative bodies / departments, other than the lead administrative body, in the*
*...implementation of the strategy?*
Structural units subordinated to the Riga City Council
*Stakeholders involved in strategy development:*
*Private organisations:* It is stated that the proposals and recommendations have been submitted by private individuals, legal entities and institutions, various target groups and experts upon the commencement of drafting of the spatial plan, as well as during the public discussion of the first and second wording of the spatial plan. The proposals have been taken into consideration.
*Research institutions:* Latvian Environmental, Geological and Meteorological Agency; Public Health Agency; State Forestry Research Institute "Silava"; Faculty of Geography and Earth Sciences, University of Latvia; Latvian Geospatial Information Agency.
*NGOs and/or citizens' initiatives:* The public involvement campaign "I am making Riga" was organised from 30.03.2004 to 17.04.2004
*Governments of neighbouring cities/regions:* Yes, the Spatial Plan of Riga for 2006-2010 is developed in the regional context as well.

## Case study comments

**Motivation and priorities for strategy development:** Location in the vicinity of the Gulf of Riga and in lowland at the mouth of three major rivers makes the city of Riga especially vulnerable to climate change impacts, especially to storm surges, coastal floods, rivers floods, and coastal erosion. Although an adaptation strategy for the city of Riga does not exist as a single document, a number of adaptation topics are addressed in other policy documents either at the national or municipal level. They provide for disaster risk management against the major adaptation challenges although the effect of climate change on the frequency

and severity of the events is not taken into consideration. For instance, the Spatial Plan of Riga introduces the concept of so-called protective zones. The Riga Bay shoreline and River Daugava banks are covered by the zoning of a coastal protection shelter belt that are at a minimum of 150 metres inland up to and including areas in the flood plain and beach and dune areas.

**Multilevel cooperation and integration with other strategies/policies:** In national documents local climate change impacts are sometimes already taken into consideration. For instance, all flood risk territories and criteria for these territories are defined in the "National Flood Risk Assessment and Management Programme for 2008-2015" (2007). The programme deals with risk management, the establishment of priority risk territories, for prevention – real time schedule and financing, flood risk impact assessment (*ex post*), the elaboration of maps for risk territories, the drawing up of plans for risk territories, including CC risk management into already existed protected plans for individual territories, etc. The programme also foresees three scenarios (with appropriate criteria and financing): (1) floods with a small likelihood of occurring, (2) medium-sized floods (possible recurrence period: 100 years or more), and (3) floods with a very strong likelihood of occurring. Furthermore, the "Management Conception for Surface Water Objects in Riga City for 2008-2013" addresses issues of sewage water management; melioration system operation and maintenance; and flood risk management.

All cities including Riga have their own civil protection plans, where natural disasters (storms, whirlwinds, earthquakes, heavy rainfalls, flood, hail, intense cold, snowstorms, icing, snowdrifts and ice jams, heat waves, drought, fires in forests and peat bogs) and preventive and protection measures, as well as the functions of institutions are described.

International cooperation has been beneficial. The INTERREG IIIB project ASTRA (Developing Policies and Adaptation Strategies to Climate Change in the Baltic Sea Region) provided the city with the vulnerability map of the potential sea level rise up to 0.7 metres and storm surges up to two and three meters. This information was included in the Freeport of Riga Development Programme but without any apparent measures to address it.

While significant advances in the field of environment protection have been made, the city could benefit from a single adaptation strategy where all the direct and indirect climate change risks are properly assessed, and at least no-regret options are identified that would reduce the risks of climate change.

**CASE STUDY 17:** **City:** Almada
**Metropolitan Area:** Lisbon metropolitan area
**Country:** Portugal

**Number of inhabitants (city):** 166 103 (2008)
**Number of inhabitants (metropolitan area):** 2 819 433 (2008)

**Strategy at national level:** Proposal: Strategy of adaptation to climate change in Portugal "*Adaptacao às Alteracoes Climáticas em Portugal Proposta de Estratégia Nacional*" (Proposal approved for public consultation July 2009).

**City or regional adaptation strategy:** The adaptation is part of the Local Climate Change Strategy which started in 2001 and is still in reformulation - Local climate change strategy – Almada *(ELAC).* There is a local council mandate for the formulation of the strategy, although the strategy is expected to be finished by the end of 2010, there is not binding agreement.
*Lead administrative body of the strategy:* The department responsible for the strategy is the department for strategic and sustainable development of the City Council of Almada.
*Strategy part of combined mitigation and adaptation strategy?* Yes.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* River floods; Sea level rise; Intense precipitation.
*Relevant for the region:* Drought and Water efficiency; Heat waves / urban heat islands; Wind / storm damage.
*Covered by adaptation strategy:* River floods; Sea level rise; Intense precipitation Intense precipitation; Drought and water efficiency; Heat waves / urban heat islands; Wind / storm damage.

**Key adaptation challenges from *indirect* climate change impacts:**
*Most relevant for the region:* Biodiversity loss; Migration; differential social impacts.
*Relevant for the region:* Water quality; Increased health and disease problems
*Covered by adaptation strategy:* Water quality; Biodiversity loss; Migration; Differential social impacts.
*Partially covered by adaptation strategy:* Increased health and disease problems.

**Sectoral coverage:**
Comprehensive, cross-sectoral adaptation strategy
*Sectors covered:* Air quality; Health; Social life and neighbourhood management; Flood and coastal zone management; Water resources management; Soil protection and biodiversity conservation, protection of green spaces; Urban and regional planning; Building and construction; Energy supply

and consumption; Regional/Local economy; Emergency planning; protection of geological natural sites (fossil cliffs, dunes...).

**Key measures:**
Almada has to deal with problems derived from sea level rise as the ocean, the estuary waterfronts and part of its territory are below sea level:
No. 1 – Inclusion of adaptation concerns in local spatial planning;
No. 2 – Withdrawal of communities installed at risk areas;
No. 3 – Protection and reinforcement of natural barriers / improvement of drainage systems.
These measures are being carried out within the Municipality administration plan.

**Resources:**
*How long did/will it take to develop the strategy?* Between one and two years.
*Resources used to develop the strategy*: Local financing - provided by Almada City Council, no information about budget , Personnel - two officials of Almada City Council and the support of the Almada Energy Agency , External support - EC co-financing if CC programmes are launched. Eventually national experts and European experts to help in specific projects.
*Vulnerability and impact/risk assessments:* Region vulnerability assessments e.g. river flood vulnerability; Impacts of changes in the availability of fish species. Planned study: impacts and vulnerability of climate change on health.

**Data and information used to develop the strategy:**
*Scenarios*: Have not reached the scenarios development phase yet.
*Climate models*: Not yet defined. Possibly build from Project SIAM II: Climate Change in Portugal. Scenarios, Impacts and Adaptation Measures.
*Reference strategies:* London and Stockholm strategies

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* The creation, implementation and evaluation/update of the strategy.
*Participation of administrative departments, other than the lead administrative body, in the development of the strategy?* Only the lead administrative body.
*...implementation of the strategy?* Not yet defined.
*Stakeholders involved in strategy development:*
*Private organisations:* Local Energy Management Agency of Almada and its members (transport operators of Almada, energy suppliers)
*Research institutions:* Universidade Nova de Lisboa.
*NGOs and/or citizens' initiatives:* Public participation processes
*Governments of neighbouring cities/regions:* Not planned

## Case study comments

**Motivation and priorities for strategy development:** The Almada adaptation strategy was initiated as a precaution, because of vulnerability related to its location near the ocean and a river waterfront. The most important motivating factors for initiating the strategy were: i) the perception of urgency, specially the high vulnerability to floods of the municipality, ii) the results of a vulnerability assessment, iii) recognition of synergies with policy objectives other than adaptation, iv) acceptance of measures/absence of conflicts and trade-offs, v) community planning processes such Local Agenda 21, vi) results of stakeholder consultations. The Local Climate Change Strategy of Almada includes mitigation and adaptation plans, incorporating GHG inventories and monitoring, vulnerability assessment and emissions scenarios - GHG Local Observatory.

**Leadership, stakeholder integration and public consultation:** The Department of Strategic and Sustainable Development of the Almada City Council takes the leadership and subcontracts a local energy agency for the development of the strategy and coordination of participants. Different institutions have responsibilities in the process, but this is seen as a technical barrier which will introduce complexity to the implementation phase. The current leader of the adaptation strategy of Almada could not answer the question of how research and politics come together.

**Multi-level cooperation and integration with other strategies/policies:** The adaptation strategy to climate change of the city of Almada is adjusted to the Global Strategy for the Municipality and Local Agenda 21 including a strong emphasis on sustainable development and it will be part of the City Council Annual Corporate Plan. There is an exchange of information between the national adaptation strategy and the Almada adaptation strategy, but the national strategy does not contain a political mandate or financial support to develop and carry out a local adaptation strategy. There is the interest to exchange information with national networks of researchers working on climate and adaptation in the future. Internationally there is the urge to contact and exchange information with international networks and municipalities that have more experience in developing and implementing adaptation actions.

**Monitoring and evaluation:** The strategy will have a process of revision and evaluation based on indicator monitoring, but there is at the moment no agreed plan.

**Difficulties encountered and ways to solve them:** The most important challenges found during the development of the strategy were: 1) *lack of data* - data has been searched in international, national and local documents, and national and local stakeholders have been contacted but the existing data is of poor quality; 2) uncertainty regarding climate prediction; 3) high complexity of climate change data, vulnerability and risks.

**CASE STUDY 18:** **City:** City of Zaragoza
**Metropolitan Area:** Zaragoza
**Country:** Spain

**Number of inhabitants (city):** 693 086 (2009)

**Strategy at national level:** National Plan for Adaptation to Climate Change (*Plan Nacional de Adaptación al Cambio Climático)* (creation 2006, in second work programme July 2009)

**City or regional adaptation strategy:** Strategy for Adaptation to Climate Change in the city of Zaragoza (*Estrategia de Adaptación al cambio climático en la Ciudad de Zaragoza*). The draft was presented to the Climate Change Commission 21 on 16/12/2009.
*Lead administrative body of the strategy:* Environmental and Sustainability Agency of the Municipality of Zaragoza (*Agencia de Medio Ambiente y Sostenibilidad de Zaragoza*).
*Strategy part of combined mitigation and adaptation strategy?* No, there are two different strategies within the global approach.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* Drought and water efficiency; Heat waves / urban heat islands.
*Relevant for the region:* Wind / storm damages; Intense precipitation, drainage and flash flooding; River floods.
*Covered by adaptation strategy:* Drought and Water efficiency; Heat waves / urban heat islands; Wind / storm damage; Intense precipitation, drainage and flash flooding; River floods.

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality; Increased health and disease problems; Biodiversity loss; migration, differential social impacts.
*Covered by adaptation strategy:* Water quality; Increased health and disease problems; Biodiversity loss; migration, differential social impacts.

**Sectoral coverage:**
Zaragoza aims to implement a comprehensive, cross-sectoral adaptation strategy.
*Sectors covered:* Air quality; Health; Social life and neighbourhood management; Flood and coastal zone management; Water resources management; Soil protection and biodiversity conservation, protection of green spaces; Waste management; Urban and regional planning; Building and construction; Transport; Energy supply and consumption; Tourism and leisure activities; Finances and insurance.

**Key measures:**
No 1 – Development of a renewable energy strategy for the Municipality of Zaragoza and the 'areas of influence'
No 2 – Create a strategy to introduce policies for saving water and improve the water quality, to contribute to adaptation to unfavourable conditions.
No 3 – Protecting biodiversity: Favour the richness of the existing ecosystems with very different characteristics within the Municipality

**Resources:**
*How long did/will it take to develop the strategy?* >2 years
*Resources used to develop the strategy*: Financial – Municipal Budget; Personnel – own personnel from the Environment and Sustainability Agency and consultation organisations (AEMET- State Agency for Meteorology; CHE – Hydrographic Confederation of the River Ebro; EAAP – Mediterranean Agronomic Institute of Zaragoza; CIRCE – Research Centre for Energy Resources and Consumption).
*Resources used to implement the strategy:* Financial – municipal budget; Personnel – own personnel from the Environment and Sustainability Agency and consultation organisations; possible external funding or aid.

**Data and information used to develop the strategy:**
*Climate scenarios:* International - IPCC SRES; National – Spanish Office for Climate Change (*Oficina Española de Cambio Climático*); Spanish Federation of Municipalities and Provinces (*Federación Española de Municipios y Provincias*)
*Climate change vulnerability and impact/risk assessments:* Region specific; Reports by the State Agency of Meteorology (Aragon Office) and of the Hydrographic Confederation of River Ebro.

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* The process of developing the strategy; Implementation of the strategy; Evaluation and periodic update of the strategy.
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy?*
AEMET- State Agency for Meteorology; CHE – Hydrographic Confederation of River Ebro; EAAP – Mediterranean Agronomic Institute of Zaragoza; CIRCE – Research Centre for Energy Resources and Consumption; political party representatives at municipal level.
*...implementation of the strategy?* Department of Urban Planning, Infrastructure, Architecture and Conservation of Infrastructure and Mobility
*Stakeholders involved in strategy development:*
*Research institutions:* Role as technical assistance for evaluating the situation: AEMET, CIRCE, CHE and EAAP.

*NGOs and/or citizens' initiatives:* Role in the participation processes: Climate Change Commission LA21, trade unions, industry organisations, environmental NGOs.
*Governments of neighbouring cities/regions:* None.
*Others:* Representatives of the municipal political parties, university, professional schools.

## Case study comments

**Motivation and priorities for strategy development:** The strategy was initiated as a precaution, and not as a direct reaction to adverse events. After the approval of the strategy for mitigating climate change and improvement of air quality in Zaragoza in 2009, the City Council officially engaged in the fight against climate change, and developed its own policies of adaptation. The adaptation strategy is expected to be approved by a Resolution of the Government of Zaragoza in 2010.

The following factors were considered to be priorities in developing the adaptation strategy: perception of urgency; available financial and personnel resources; acceptance of measures and (absence or limited) conflicts and trade-offs; and community planning process.

**Multi-level cooperation and integration with other strategies/policies:** The adaptation strategy is related to the strategy for climate change and improvement of air quality of the city and to the implementation of Agenda 21.

The adaptation strategy at national level covers the Autonomous Communities in the institutional architecture of developing the plan and does not mandate the creation of local and regional adaptation strategies.

**Leadership, stakeholder integration and public consultation:** The various Commission 21 goals are included in the Agenda 21 process as a framework for participation of and consultation with stakeholders in selected themes, which include the development of the adaptation strategy. The strategy will be subject to on-going public consultation from the moment it enters into force.

**CASE STUDY 19:** **City:** Stockholm
**Metropolitan Area:** Metropolitan Stockholm
**Country:** Sweden

**Number of inhabitants (city):** 829 417 (2009)
**Number of inhabitants (metropolitan area):** 2 019 182 (2009)

**Strategy at national level:** While a climate change adaptation policy at national level is presently in preparation—for which roughly €27million have been earmarked for the period 2009-2011--an integrated climate and energy policy was approved in 2009. The latter is considered to be highly ambitious and aims at drastically decreasing the country's dependence on fossil fuels and at reducing its negative impacts to the environment. The first targets have been set for year 2020.

**City or regional adaptation strategy:** The central government has granted overarching responsibilities for the coordination of regional adaptation strategies to the country's 21 county administrative boards (*Länsstylrelse*[22]). Roughly €2.3million p.a. are to be distributed among the 21 *Län* in the period 2009-2011 to encourage the creation of these plans. The city of Stockholm conducts annual risk and vulnerability assessments to cope with adaptation in the short term.

*Lead administrative body of the strategy:* Central Stockholm Administration
*Strategy part of combined mitigation and adaptation strategy?*
Yes. The adaptation strategy will be in line with the integrated climate and energy policy at national level. For example, Stockholm's key measure listed in this study consists of the development of an area that combines sustainable development and mitigation actions with adaptation measures.

**Key adaptation challenges from *direct* climate change impacts:**
*Relevant for the region:* River floods; Intense precipitation, drainage and flash flooding; Drought and water efficiency; Heat waves / urban heat islands
Wind / storm damages.
*Covered by adaptation strategy:* Drought and water efficiency; Intense precipitation, drainage and flash flooding; Drought and Water efficiency; River floods.
*Partially covered by adaptation strategy:* Wind / storm damage.

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality; Increased health and disease problems; Biodiversity loss.
*Covered by adaptation strategy:* Water quality; Increased health and disease problems.

[22] Sweden is divided into 21 counties, or *Län*, of which *Stockholms Län* is one. Its jurisdiction includes the city of Stockholm.

*Partially covered by adaptation strategy:* Increased health and disease problems; Biodiversity loss.

**Sectoral coverage:**
The strategy will be comprehensive and cross-sectoral.

**Key measures:** No key measures *per se* could be listed, but the following was identified as a key action in favour of adaptation: Development of residential and commercial urban area "Stockholm Royal Seaport"

**Resources:**
*How long did/will it take to develop the strategy?* >2 years.
*Resources used to develop the strategy*:
Personnel→10-15 persons in the city level working partly on the development of the adaptation strategy.
External support → In addition to direct support and coordination from the regional government (*Stockholms Län*), the city consults with several universities and research institutions, such as the KTH Royal Institute of Technology.

**Data and information used to develop the strategy:**
*Climate scenarios:* IPCC SRES
*Climate models:* Several from the Swedish Meteorological and Hydrological Institute (SMHI).
*Climate change vulnerability and impact/risk assessments:* Produced annually at city level.

**Involvement in strategy development and implementation:**
*Binding political commitment exists:* Both at national and city level, authorities have shown commitment to working toward producing an adaptation strategy and implementing relevant actions to support the efforts against climate change.
*Participation of administrative bodies / departments, other than the lead administrative body, in the development of the strategy?* Several departments of the city administrations are involved. In the particular case of the key measure identified, the Health and Environmental Administration, the City Development Administration, the City Planning Administration and the Local Municipal Administration are involved.
*...implementation of the strategy?* Same as above.
*Stakeholders involved in strategy development:* Active stakeholder participation has been conducted in the key action listed above, "Royal Seaport".
*Governments of neighbouring cities/regions:* Support from the regional authorities—*Stockholms Län* in this case—is given to all the municipalities within its jurisdiction.

## Case study comments

**General background:** As per national mandate, regional and municipal adaptation strategies will be of utmost importance. The country's 21 *Län* are mandated to provide dedicated support to municipalities in realising individual plans. At the same time, municipalities bear a large part of responsibility on adaptation and are expected to deliver a plan. This 'bottom-up' approach has obvious advantages, such as better knowledge of local conditions and threats, but it also puts significant pressure on municipalities as regards the input expected of them. Larger cities (like Stockholm) mostly benefit because they often have certain resources and expertise in-house, but small municipalities with limited resources and expertise—and lack of funding to employ them—face a considerable obstacle. In this latter case, networks of municipalities can play an important role in furthering the adaptation objectives.

**Motivation and priorities for strategy development:** In Stockholm, adaptation work in the short run is primarily based on annual risk and vulnerability assessments. As a following step, the city will focus on two main issues: heat waves and sea level rise. The final strategy, as presumably in the majority of Swedish cases, is likely to be a mix of local and central measures.

**Difficulties encountered and ways to solve them:** Central Swedish agencies and departments, however, may have overstated the capacity of *Län* authorities to deliver complete support to municipalities. Even the well-staffed city of Stockholm feels a lack of guidance from central government. For example, legislation concerning building regulations is not yet fully aligned with climate change adaptation concerns. This is a clear sign of the infancy of actions against climate change, which, internationally, is more the rule than the exception. On the other hand, the central government will conduct an evaluation on the question of adaptation at country-wide level in 2015.

Another important issue is creating and increasing awareness and interest about climate change adaptation which so far is often considered low. The reasons are, on one hand, that Stockholm has not yet experienced particularly extreme weather events, and on the other that conclusions drawn on adaptation needs are often based on uncertain assumptions coupled with the complexity in understanding and marketing the notion of climate change issues. The Swedish government recognises the need to significantly invest on research in the area. The availability of several adaptation strategies at municipality level throughout the country may be a timely driver for increased awareness and acceptance of the concept of adaptation.

**CASE STUDY 20:** **City:** City of Amsterdam
**Metropolitan Area:** Amsterdam Metropolitan Area
**Country:** The Netherlands

**Number of inhabitants (city):** 755 000 (2009)
**Number of inhabitants (metropolitan area):** 2 200 000 (2009)

**Strategy at national level:** National Delta Plan and National Water Management Plan (2008 and 2009 respectively). First implementation steps have been taken.

**City or regional adaptation strategy:** An explicit adaptation strategy is not in place. However, the spatial plan Amsterdam and Amsterdam water protection plan (*Waterbestendig*) address adaptation issues. To be finalised in 2010.
*Lead administrative body of the strategy:* City of Amsterdam
*Strategy part of combined mitigation and adaptation strategy?* No.

**Key adaptation challenges from *direct* climate change impacts:**
*Most relevant for the region:* river floods, sea level rise, intense precipitation, drainage and flash flooding, Drought and water efficiency
*Relevant for the region:* heat waves, wind / storm damages
*Partially covered by adaptation strategy:* Sea level rise, Intense precipitation, drainage and flash flooding; Heat waves / urban heat islands, River floods, Drought and water efficiency

**Key adaptation challenges from *indirect* climate change impacts:**
*Relevant for the region:* Water quality, biodiversity loss, increased health and disease problems
*Partially covered by adaptation strategy:* Water quality, biodiversity loss, increased health and disease problems

**Sectoral coverage:** Sector-specific strategy aimed at cross-sectoral solutions
*Sectors covered:* Urban and regional planning; Transport, Energy supply and consumption; Air quality; Health; Flood and coastal zone management, Water resource management, soil protection and biodiversity conservation, protection of green spaces, building and construction, emergency planning.

**Key measures:**
No. 1 – Developing a new strategy against flooding and its consequences
No. 2 – Developing a new strategy against flooding and rainstorm impacts
No. 3 – Developing a new strategy against flooding and drought impacts

**Resources**
*How long did/will it take to develop the strategy?* >2 years
*Resources used to develop the strategy:* Regional and local funds

*Resources used to implement the strategy:* State, regional and local funds

**Data and information used to develop the strategy:**
*Climate scenarios:* National – KNMI scenarios
*Climate models:* None yet
*Climate change vulnerability and impact/risk assessments:* None. Based on best professional judgement.

**Involvement in strategy development and implementation:**
*Binding political commitment exists regarding:* developing and implementing the strategy.
*Participation of administrative bodies / departments, other than the lead administrative body, in the .development of the strategy?* Spatial Planning Dept., regional water boards, city water authority, environmental department, Province of Noord-Holland.
*...implementation of the strategy?* Not yet
*Stakeholders involved in strategy development:*
*Private organisations:* Yes
*Research institutions:* Yes
*NGOs and/or citizens' initiatives:* Yes
*Governments of neighbouring cities/regions:* Yes. Overall mostly governmental bodies and institutes are involved.

## Case study comments

**General background:** The City of Amsterdam developed its spatial planning and water strategies in response to the national strategies, in an attempt not to be bound to follow national policies passively, but rather as a region and city to make up its own mind, "to influence the national policy and to take our own responsibility."

**Multilevel cooperation and integration with other strategies/policies:** Sustainability is the base for the strategies developed, and both strategies are integrated. However, no overarching integrated management approach is followed. Amsterdam is presently translating the two strategies into concrete measures. Amsterdam indicates that most strategies dealing with adaptation are similar in the Netherlands. This may be due to regions' common connection to water and the country's small size. There seems to be a lot of information exchange nationally in developing and disseminating adaptation strategies.

**Difficulties encountered and ways to solve them:** Lack of political commitment due to a sense of 'no urgency' is quoted as a key challenge in developing the strategy.

**Monitoring and evaluation:** Finally no plan to evaluate the implementation of the strategy (no indicators, no targets) and no evaluation exercise are foreseen.

# 4. Analysis of individual adaptation measures

This chapter presents the findings on individual adaptation measures. Specifically, the objective is to deliver an inventory of policy tools for the development, design, implementation and continuous management of adaptation strategies, drawing on lessons learned from best practices and experiences identified in the case studies, building on the literature on adaptation and cities and building the platform for recommendations and practical suggestions on how to handle those issues and problems throughout the management cycle leading from a policy's planning to implementation, monitoring and evaluation.

The chapter structure is as follows. In section 4.1 the selected adaptation measures are introduced, along with the clustering of measures, and an overall analysis of the clusters identified. Section 4.2 includes fact sheets of individual clusters of measures.

## 4.1. Overview of results

**Selected adaptation measures**

Thirty-one individual measures were included in the analysis (see Table 4). Individual measures are drawn from 18 of 20 case study cities (Bremen and Amsterdam were not able to provide information on individual measures). For each measure a one-page summary factsheet and an applicability check table were prepared, the templates for which are presented in Annex 4. Criteria such as effectiveness of adaptation, efficiency/costs and benefits, procedural aspects and framework conditions for decision-making were included. Brief descriptions and applicability check tables for individual measures included in the analysis are presented in Annex 5.

**Table 4: Adaptation measures included in the analysis**

| ID | Name of Measure | City | Country |
|---|---|---|---|
| A-1 | Inclusion of climate adaptation concerns in urban spatial planning of Trafaria village | Almada | Portugal |
| Bo-1 | Measures to reduce erosive impacts from rainfall deluges | Bologna | Italy |
| Bo-2 | Water conservation measures | Bologna | Italy |
| Bo-3 | Measures to improve the urban micro-climate | Bologna | Italy |
| Bu-1 | Heat Alert System | Budapest | Hungary |
| Bu-2 | Traffic restrictions during the Smog Alert days | Budapest | Hungary |
| C-1 | Expansion of sewer grid and set up of Sustainable Drainage Systems (SUDS) | Copenhagen | Denmark |

| | | | |
|---|---|---|---|
| D-1 | Energy-efficient air-conditioning | Dresden | Germany |
| D-2 | Near-natural management of rainwater | Dresden | Germany |
| D-3 | Designation of a new drinking water protection area (Wachwitz) | Dresden | Germany |
| Ha-1 | RISA-Project (RegenInfraStrukturAnpassung): Infrastructural Adaptation for Rainwater Management | Hamburg | Germany |
| He-1 | Development of climate change scenarios for Helsinki Metropolitan Area | Helsinki | Finland |
| Lo-1 | To retrofit up to 1.2m homes by 2015 to improve the water and energy efficiency of London homes | London | United Kingdom |
| Lo-2 | London Urban Greening Programme | London | United Kingdom |
| Ly-1 | Develop and increase the urban tree canopy | Lyon | France |
| M-1 | Adaptation Strategies for Climate Change in the Urban Environment and Green Roofs | Manchester | United Kingdom |
| M-2 | EcoCities | Manchester | United Kingdom |
| P-1 | Moveable barriers as a flood protection instrument | Prague | Czech Republic |
| R-1 | Protection zones/Spatial Plan of Riga for 2006-2018 | Riga | Latvia |
| R-2 | Dunes maintenance along the Riga Bay coastal line | Riga | Latvia |
| S-1 | Development of residential and commercial urban area “Stockholm Royal Seaport” | Stockholm | Sweden |
| T-1 | Building capacity of the fire brigade | Tatabánya | Hungary |
| T-2 | The Local Heat Alert System (HAS) of Tatabánya | Tatabánya | Hungary |
| T-3 | Smart Sun Educational Programme | Tatabánya | Hungary |
| Ve-1 | City of Venice – Tide Forecasting and Early Warning Centre (Tide Centre) | Venice | Italy |
| Ve-2 | Urban maintenance for the physical and environmental safeguarding of Venice and the Venetian Lagoon | Venice | Italy |
| Vi-1 | Promotion of district cooling projects in Vienna | Vienna | Austria |
| Vi-2 | Spatial planning to reduce climate change impacts and costs | Vienna | Austria |
| Z-1 | Renewable Energy Strategy of the Municipality of Zaragoza and its ‘areas of influence’ | Zaragoza | Spain |
| Z-2 | Create a strategy to introduce policies for saving water and to improve the water quality in order to adapt to unfavourable conditions | Zaragoza | Spain |
| Z-3 | Protecting biodiversity – Favour the richness of the existing ecosystems with very different characteristics within the Municipality | Zaragoza | Spain |

## Clusters of measures

Building on the summary fact sheets and applicability check tables, individual measures were analysed and clustered with other measures that consisted of similar characteristics or techniques and shared similar objectives, thus creating 19 ‘clusters of measures’. An individual measure may be listed in separate

clusters if the measure is deemed to cover more than one function and/or fit into more than one cluster. By relating comparable actions across different European cities and metropolitan areas we aimed to recognise the similarities and differences in their implementation and in doing so produce a blueprint for other cities and towns. The measure clusters were further grouped according to the challenge that they addressed. Table 5 shows the individual measures grouped according to the corresponding climate change challenge and cluster, as well as the city that is implementing the measure.

### Table 5: Clusters of adaptation measures

*Note: To avoid duplication, each cluster of measures is grouped under only one adaptation challenges, which has been considered the most relevant one. However, many of the measures listed below are also suited to address other adaptation challenges. For a more complete picture, please refer to Table 7.*

| Cluster No. | Cluster of measures | Measure ID | Measure | City |
|---|---|---|---|---|
| Urban heat island / Heat waves | | | | |
| 1 | Increasing tree canopy | Lo-1 | Street Tree Programme | London (UK) |
| | | Ly-1 | Increasing tree surface | Lyon (FR) |
| | | Bo-3 | Building Impact Index | Bologna (IT) |
| | | * | Local Climate Change Action Plan | Tatabánya (HU) |
| 2 | Green roofs | Lo-1 | Urban greening programme (100,000 $m^2$ of green roofs by 2012) | London (UK) |
| | | M-1 | Green Roofs Project | Manchester (UK) |
| | | Vi-2 | Planning and information programme | Vienna (AT) |
| | | * | Local Climate Change Action Plan | Tatabánya (HU) |
| 3 | Building regulations | Bo-3 | Building Impact Index | Bologna (IT) |
| 4 | District cooling | D-1 | Energy efficient air conditioning | Dresden (DE) |
| | | Vi-1 | District cooling projects | Vienna (AT) |
| 5 | Heat alert system | T-2 | Local Heat Alert System | Tatabánya (HU) |
| | | Bu-1 | Heat Alert System | Budapest (HU) |
| | | Bu-2 | Traffic restrictions during smog alert | Budapest (HU) |
| 6 | Heat threat educational and awareness programme | T-3 | Smart Sun Educational Programme | Tatabánya (HU) |
| | | Bu-1 | Communication Strategy on Environment and Health | Budapest (HU) |

| Cluster No. | Cluster of measures | Measure ID | Measure | City |
|---|---|---|---|---|
| Droughts & water efficiency | | | | |
| 7 | Policies for water saving | Z-2 | Strategy on water saving policies | Zaragoza (ES) |
| | | Bo-2 | Water conservation building code | Bologna (IT) |
| 8 | Building retrofitting | Lo-1 | Water and energy efficient homes | London (UK) |
| 9 | Securing drinking water resources | D-3 | Designation of new drinking water protection area | Dresden (DE) |
| Biodiversity loss | | | | |
| 10 | Biodiversity strategy | Z-3 | Biodiversity strategy | Zaragoza (ES) |
| 11 | Capacity building for fire workers | T-1 | Capacity building for fire workers | Tatabánya (HU) |
| River floods / sea level rise | | | | |
| 12 | Flood risk mapping & Flood alert systems | Ve-1 | Tide forecasting/warning Centre | Venice (IT) |
| | | ** | Flood alert system | Prague (CZ) |
| | | R-1 | Spatial planning | Riga (LV) |
| | | A-1 | Spatial planning in vulnerable neighbourhood | Almada (PT) |
| 13 | Moveable barriers | P-1 | Moveable barriers | Prague (CZ) |
| Intense precipitation | | | | |
| 14 | Water storage and drainage systems | D-2 | Near-natural rainwater management | Dresden (DE) |
| | | C-1 | Sustainable Drainage System | Copenhagen (DK) |
| | | B-1 | Creation of Water storage areas | Bologna (IT) |
| 15 | Rainwater management | Ha-1 | RISA project | Hamburg (DE) |
| Overarching | | | | |
| 16 | Adaptive urban development | S-1 | Development of new neighbourhood | Stockholm (SE) |
| 17 | Vulnerability assessment | He-1 | Development of climate change scenarios | Helsinki (FI) |
| | | M-2 | Blueprint for development of adaptation strategy | Manchester (UK) |
| 18 | Mitigation efforts to reduce adaptation needs | Z-1 | Renewable Energy Strategy | Zaragoza (ES) |
| 19 | Comprehensive inclusion of adaptation concerns in municipal process | * | Local Climate Change Action Plan | Tatabánya (HU) |

* Measure is part of Tatabánya's Local Climate Change Action Plan described in section 3.2, Case Study 13.
** Prague's flood warning system is part of the flood defence plan referred to in section 3.2, Case Study 2.

## Matrices of adaptation measures

Three matrices of adaptation measures are presented below. In Table 6, clusters of adaptation measures are classified according to the stage in the adaptation management process (management step), type of instruments used for implementation, effectiveness (time), efficiency (cost/benefit), and transferability. Table 7 shows the direct (high connection) and more indirect (secondary level connection) links between clusters of measures and climate challenges. Table 8 illustrates the sectors which are addressed by individual clusters of measures.

## Table 6: Main characteristics of clusters of measures

*Note: To avoid duplication, each cluster of measures is grouped under only one adaptation challenges, which has been considered the most relevant one. However, many of the measures listed below are also suited to address other adaptation challenges. For a more complete picture, please refer to Table 7.*

**Legend:**
**Management step:** Baseline review (BR), Target setting (TS), Political commitment (PC), Implementation & monitoring (I&M), Reporting & evaluation (R&E)
**Effectiveness (time):** Long (>7 years), Medium (3-6 years), Short (1-2 years).
**Efficiency (cost/benefit):** High, Medium, Low, Uncertain.
**Transferability:** High, Medium, Low.

| Cluster of measures | Management step | Instrument for implementation | Effectiveness (time) | Efficiency (cost/benefit) | Transferability | Reference case |
|---|---|---|---|---|---|---|
| **URBAN HEAT ISLAND / HEAT WAVES** | | | | | | |
| Increasing tree canopy/Green grids | TS, PC, I&M | Regulatory, fiscal, voluntary | Medium | Medium | High | Bologna, London, Lyon, Tatabánya |
| Green roofs | TS, PC, I&M | Regulatory, fiscal, planning, communicational, voluntary | Short | High | High | London, Manchester Tatabánya, Vienna |
| Building regulations | PC, I&M | Regulatory | Short | High | Medium | Bologna |
| District cooling | PC, I&M | Planning, regulatory, fiscal, communicational, monitoring | Medium-long | Medium | Low | Dresden, Vienna |
| Heat alert system | I&M | Regulatory, communicational, planning, monitoring | Short | High | High | Budapest, Tatabánya |
| Heat threat educational programme | I&M | Communicational | Short | Medium | High | Budapest, Tatabánya |

| Cluster of measures | Management step | Instrument for implementation | Effectiveness (time) | Efficiency (cost/benefit) | Transferability | Reference case |
|---|---|---|---|---|---|---|
| **DROUGHTS & WATER EFFICIENCY** | | | | | | |
| Policies for water saving | I&M, R&E | Regulatory, fiscal, monitoring | Short | High | Medium | Bologna, Zaragoza |
| Building retrofitting | PC, I&M | Fiscal | Medium | Medium | High | London |
| Securing drinking water resources | I&M | Regulatory, planning | Medium-Long | Medium-High | Low | Dresden |
| **BIODIVERSITY LOSS** | | | | | | |
| Biodiversity strategy | BR, PC, I&M | Regulatory | Long | Uncertain | Low | Zaragoza |
| Capacity building for fire workers | I&M | Communicational | Short | High | High | Tatabánya |
| **RIVER FLOODS / SEA LEVEL RISE** | | | | | | |
| Flood risk mapping & Flood alert systems | BR, PC, I&M | Communicational, planning, monitoring | Short | High | High | Almada, Prague, Riga, Venice |
| Moveable barriers | I&M | Fiscal | Long | High | Medium | Prague |
| **INTENSE PRECIPITATION** | | | | | | |
| Water storage & drainage systems | PC, I&M | Regulatory, planning, fiscal | Medium | Medium-High | Low | Bologna, Copenhagen Dresden |
| Rainwater management | I&M | Planning, communicational | Short-Medium | Medium | Medium-High | Hamburg |
| **OVERARCHING** | | | | | | |
| Adaptive urban development | I&M | Planning, fiscal | Long | High | High | Stockholm |
| Vulnerability assessment | BR | Planning, communicational | Medium | High | High | Helsinki, Manchester |
| Mitigation efforts to reduce adaptation needs | I&M | Planning, fiscal voluntary | Medium-long | Uncertain | Medium | Zaragoza |

| Cluster of measures | Management step | Instrument for implementation | Effectiveness (time) | Efficiency (cost/benefit) | Transferability | Reference case |
|---|---|---|---|---|---|---|
| Adaptive Urban Management | BR, TS, PC, I&M, R&E | Regulatory, communicational, planning, monitoring, voluntary | Medium-long | High | High | Tatabánya |

## Table 7: Climate challenges covered in clusters of measures

**Legend**. A: High connection, B: Secondary level connection.

| Challenges | Cluster of measures | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| River floods / Sea level rise | | | | | | | | | | | | A | A | A | A | | | | |
| Intense precipitation, drainage and flash flooding | | B | | | | | | B | B | | | A | | A | A | A | | | |
| Drought and water efficiency | B | B | | | | | A | A | A | | B | | | A | | | | | |
| Heat waves / Urban heat islands | A | A | A | A | A | A | | B | | | B | | | | | | | | |
| Wind / Storm damage | | B | | | | | | | | | | | | | | | | | |
| Water quality | | | | | | | A | | B | | | | | B | | | | | |
| Increased health and disease problems | B | | | | | B | | | | | | | | | | | | | |
| Biodiversity loss | | | | | | | | | B | A | A | | | B | | | | | |
| Other (Wild fires) | | | | | | | | | | | A | | | | | | | | |
| Overarching | | | | | | | | | | | | | | | | A | A | A | A |

## Table 8: Sectors covered in clusters of measures

**Legend**. A: High connection, B: Secondary level connection, AB: Depends on local conditions, X: Other sector has relevant connections.

| Sectors | Clusters of measures | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| Air quality | A | B | | | | | | | | | | | | | | | A | A | A |
| Health | B | B | B | | A | A | | B | B | | | | | B | | A | A | AB | A |
| Social life and neighbourhood management | | | A | | | | | | | | | | | | B | A | A | | A |
| Flood and coastal zone management | | B | | | | | | | | | | A | | | | AB | AB | | AB |
| Water resource management | A | A | | | | | A | A | A | | | A | A | A | A | A | A | | A |
| Soil protection and biodiversity conservation, protection of green spaces | B | B | B | | | | | | B | A | A | | | B | | A | A | | A |
| Waste management | | | | | | | | | | | | | | | | | A | | A |
| Urban and regional planning | | | A | A | | | | | A | | | A | | A | A | A | A | | A |
| Building and construction | B | A | A | A | | | | A | | | | A | B | | A | A | A | A | A |
| Transport | | | | | | | | | | | | | | | B | A | A | | A |
| Energy supply and consumption | B | A | A | A | | | B | A | | | | | | | | A | A | A | A |
| Regional / Local economy | | | | | | | | | | | | | | | | A | A | B | A |
| Tourism and leisure activities | B | | | | | | | | B | B | | | | B | | | A | | A |
| Emergency planning | | | | | | A | | | | | | A | A | | A | | AB | | AB |
| Finance and insurance | | | | | | | | | | | | | | | B | | B | | B |
| Others | | | | | | X | | | | | X | | | | | | | | |

**Approaches to adaptation based on individual measure analysis**

Based on the analysis of individual measures, four approaches can be identified as to how cities confront adaptation issues. These approaches include:

Protection and prevention-oriented approach. Based on particular conditions of a city – and mostly driven by extreme weather events – adaptation includes specific reaction and alert systems as immediate options to severe climate events depending on the challenges confronting the city. Clusters of measures around this protection and prevention-oriented approach include heat or flood alert systems, infrastructural adaptation planning and moveable barriers. Some examples:

- Budapest and Tatabánya have developed heat alert systems, with regulation and planning components (also communicational, which is related to the next approach);
- Flood alert systems in Venice and Prague (in the case of Prague, complemented by movable barriers as a flood protection instrument).

Communication-oriented approach. Information and communication to citizens is crucial in attempts to become resilient to climate change. This communication can take the form of emergency planning (for example the Tide Forecasting/Warning Centre in Venice) as well as awareness-raising communication (for example the Smart Sun Educational Programme of Tatabánya). While both have an obvious major importance, the latter shares responsibilities to cope with extreme events with citizens and stakeholders in general, equipping them with tools necessary to react to these events. This approach - ‘capacity building of citizens' - is considered an immediate low cost option. However, awareness-raising communication needs to be strategically planned in timing, in wide-reaching delivery as well as frequently repeated in order to be effective.

Project-oriented approach. Other cities have included adaptation aspects by opportunity in urban development programmes and projects, however, not yet based on a comprehensive adaptation strategy approach, and considered here as project-oriented approach, by which individual projects of urban development aim to provide solutions to deteriorating conditions, or conditions expected to start deteriorating in the near future. These have been clustered as adaptive urban development, increasing tree canopy, green roofs, building regulations, policies for water saving, among others. Some examples:

- Stockholm by taking a holistic vision in transforming a brownfield site into a neighbourhood adapted to a changing climate, and as well incorporating mitigation measures;

- Almada by seeking to adapt one of its neighbourhoods located in a flood-risk area to the changing conditions through better understanding of risks, and planning accordingly.

Whether the foundation-oriented phase is developed by a city or not, the project-oriented approach will be a critical (next) stage to test the capacities, commitment and resilience of a city.

Strategy-oriented approach. Only a few cities in the study have a strategy-oriented approach, meaning that they focus on creating a solid base on which to build an umbrella strategy. These cities might either have not been affected by immediate emergencies, or have built up their strategies based on longer-term experiences. This, however, cannot be proven within the scope of this assessment. The examples have been clustered in principle as vulnerability assessment measures. Some examples:

- Tatabanya with its Local Climate Change Action Plan: a comprehensive approach from which to develop a mitigation and adaptation strategy. (Clustered under comprehensive inclusion of adaptation concerns in municipal processes);
- Helsinki with a formal exercise to develop a strong theoretical foundation for the development of a comprehensive plan;
- Manchester by developing a blueprint to serve as basis for decision making in planning an adaptation strategy.

## 4.2. Catalogue of clusters of individual adaptation measures

**Name of challenge:** ***Urban heat island/heat waves***
**Cluster of measures:** ***Increasing tree canopy (1)***

**Applied in:** London (UK), Lyon (FR), Bologna (IT), Tatabánya (HU)

**Climate change challenge:** heat waves and urban heat island effect; water efficiency; increased health and disease problems.

**Sector:** air quality; health; water resources management; soil protection and biodiversity conservation; protection of green spaces; energy supply and consumption; building and construction; tourism and leisure.

**Adaptation objective:** reduce risks and sensitivity influenced by territorial vulnerability to temperature peaks, which often result in a higher rate of mortality and a diminishing quality of life.

**Related to management step:** target setting; political commitment; implementation and monitoring.

**Type of instrument(s) used for implementation of measure:** regulatory and fiscal instruments; voluntary agreement if possible.

**Description:** increase tree canopy and shade cover, create an urban network of green areas, integrating trees and plants in public roads and spaces; include alternative measures of building cooling systems; mitigation measures (e.g. promotion of energy efficiency in buildings).

**Summary assessment:** tree cover has increased in many European cities in the last 20 years. This measure has several positive side effects and synergies (e.g. conservation of biological diversity, quality of life and leisure activities) with other urban policies; this creates a need for intersectoral communication and solutions.

**Conclusion regarding transferability and lessons learnt:** Urban greening programmes can be designed and implemented in any European city. The measure efficiency and efficacy largely depend on quantity of trees, quality of their growth, size and adaptation to the site's specific conditions and require technical expertise and innovative interdisciplinary approaches. An intermediate structure that can link public, private and research actors and an intersectorial communication and dialogue contribute to the success of the measure as well.

**Name of challenge:** ***Urban heat island/heat waves***
**Cluster of measures:** ***Green roofs (2)***

**Applied in:** London (UK), Manchester (UK), Vienna (AT), Tatabánya (HU)

**Climate change challenge:** heat waves and urban heat island effect; intense precipitation and river floods; storm damage; water efficiency.

**Sector:** air quality; health; flood and coastal management; water resources management; soil protection and biodiversity conservation; protection of green spaces; energy supply and consumption; building and construction.

**Adaptation objective:** reduce risk and sensitivity; coping with extreme events (floods); raise awareness through studies and information campaigns.

**Related to management step:** target setting; political commitment; implementation and monitoring.

**Type of instrument(s) used for implementation of measure:** regulatory, fiscal, planning and informational instruments; voluntary agreement if possible.

**Description:** green roofs are able to absorb a large amount of the rainwater which would otherwise end up in the sewers (therefore preventing from floods and combined sewer overflows) and they also have a number of other advantages: they reduce the temperature in the city, create a better indoor climate, offer a living habitat to plants and animals as well as offering additional green recreational spaces where people can spend time in the city.

**Summary assessment:** it is unlikely that the measures would negatively affect other sectors or agents in terms of their adaptive capacity, or that they would exacerbate other environmental pressures. While it is fairly easy to estimate the direct benefits (e.g. decrease of the costs of wastewater treatment, general saving of water costs by reusing rainwater as service water, for example for flushing and cleaning purposes), it is harder to estimate the more indirect ones (e.g. the capacity of green roofs to help cool down the temperature during summer and to act as heat insulator in winter, providing therefore energy cost savings; the protection of urban biodiversity; an increased quality of life; economics benefits deriving from an expanding tourism).

**Conclusion regarding transferability:** The numerous past and on-going experiences with Sustainable Drainage Systems (green roofs in this specific case) in Europe demonstrate the high potential of transferability of the above mentioned measures. This does not mean, of course, that these instruments do not require an extensive preparation, expertise or a legislative and cultural context keen on adopting innovative solutions.

**Name of challenge:** ***Urban heat island/heat waves***
**Cluster of measures:** ***Building regulations (3)***

**Applied in:** Bologna (IT) - Environment and Quality Unit

**Climate change challenge:** heat waves and urban heat island effect

**Sector:** health, social life and neighbourhood management, soil protection and biodiversity conservation, protection of green places, urban planning, building and construction, energy supply and consumption

**Adaptation objective:** reduce risk and sensitivity

**Related to management step:** political commitment and implementation

**Type of instrument(s) used for implementation of measure:** Mostly regulatory instruments

**Description:** The new (2009) building regulations included a number of measures that will help improve the micro/climate in areas of the city. Two of the most significant aspects were requirements to include many plants (selected species) outside new building developments, and for these new buildings to use light colours on the roof to help reduce urban heat island impacts. The building regulations introduced the concept of a "Building Impact Index" that allows developers a lot of choice as to how they achieve the desired results.

**Summary assessment:** This measure needs to be evaluated and reviewed again once it has been in operation for longer.

**Conclusion regarding transferability:** Conclusions about this measure need to wait until it has been in operation for longer. Transferability will partly depend on political systems and the degree of difficulty to suggest policy changes from a bottom-up approach.

**Name of challenge:** ***Urban heat island/heat waves***
**Cluster of measures:** ***District cooling (4)***

**Applied in:** Dresden (DE), Vienna (AT)

**Climate change challenge:** heat waves and urban heat island effect; increasing average temperatures

**Sector:** building and construction; energy supply and consumption; urban and regional planning

**Adaptation objective:** reduce risk and sensitivity

**Related to management step:** political commitment, implementation and monitoring

**Type of instrument(s) used for implementation of measure:** regulatory and fiscal instruments; informational, planning and monitoring instruments

**Description:** Two options are used to respond to the increased demand for air conditioning in an energy-efficient way: (1) prioritising absorption cooling (which allows the use of excess heat from other processes) over compression cooling (which mainly uses electric energy); (2) using district cooling instead of local cooling. In Vienna, as well as in Dresden, both options are also combined with each other. The absorption chilling systems in Dresden are exclusively powered by excess heat from combined heat and power (CHP) plants, whereas Vienna also uses heat from waste incineration.

**Summary assessment:** The demand for cooling is independent from climate change as it is also driven by increasing needs for comfort. The measure creates synergies with greenhouse gas mitigation efforts and may contribute to reduced energy dependency. Since investments costs for absorption cooling are higher than for compression cooling, absorption cooling requires external funding or cross-subsidies. While the measures applied in Dresden were mainly based on business decisions by the local energy supplier, the measures taken in Vienna also benefited from a strong political commitment and institutional endorsement and met a high degree of acceptance by stakeholders.

**Conclusion regarding transferability:** Both technologies are only applicable and efficient under certain conditions. A basic requirement is that a district heating system based on CHP is in place. Application of absorption cooling is only warranted where there is a regular need for air conditioning (high base load). Application of district cooling requires a certain density of buildings / connections and sufficient proximity to the supply station.

**Name of challenge:** ***Urban heat island/heat waves***
**Cluster of measures:** ***Heat alert system – HAS (5)***

**Applied in:** Tatabánya (HU), Budapest (HU)

**Climate change challenge:** heat waves and urban heat island effect

**Sector:** public health; communal services

**Adaptation objective:** To decrease damage to human health during heat waves

**Related to management step:** implementation and monitoring

**Type of instrument(s) used for implementation of measure:** regulatory instruments; informational, planning and monitoring instruments.

**Description:** heat alerts and extreme heat alerts are called when an oppressive air mass is forecast, and the likelihood of deaths may increase due to high temperatures and other factors. During an Extreme Heat Alert there may be more weather-related deaths because the heat has become more severe or is lasting longer.

**Summary assessment:** The city of Tatabánya has created its own system of 3-level public HAS. When the Mayor declares an alert, faxes are sent to the local media as well as 22 organisations each having its own procedure for action. The population is notified through the local media messages and flyers that provide information on efficient measures to combat heat.

In Budapest, under the Heat Alert of second and third level, special action plans are developed for the organisations concerned; for instance, health institutions get ready for the increased number of patients with heart ailments and women giving premature births, the ambulance service increases the cars on duty for one shift by approximately one third, mass media distribute information on the Heat Alert within the blocks of news and produce special broadcasts/articles to alert citizens, the municipality provides some extra communal services.

**Conclusion regarding transferability:** The systems of environmental alerts (heat, UVA, and smog) are transferable at low cost. The systems are robust; however, a high level cooperation from the organisations involved is strongly required. They should carefully assess their resources, possibilities and needs, and stick strictly to the action plans developed on the basis of this assessment.

**Name of challenge:** ***Urban heat island/heat waves***
**Cluster of measures:** ***Heat threat educational and awareness programme (6)***

**Applied in:** Tatabánya (HU), Budapest (HU)

**Climate change challenge:** heat waves and urban heat island effect; increased health and disease problems

**Sector:** public health; emergency; education

**Adaptation objective:** To prevent harmful impact of high temperature and high solar activity on human health

**Related to management step:** implementation and monitoring

**Type of instrument(s) used for implementation of measure:** information campaigns

**Description:** in order to lessen the impact of unfavourable outdoor conditions such as heat waves (and other extreme events) and air pollution, information about them - containing the description of adverse effects on human health and the measures to decrease the impacts addressed to the most vulnerable groups of the citizens - is widely distributed through local media. Under the "Smart Sun Educational Programme", set up in Tatabánya, different vulnerable groups learn about the harmful effects of the heat waves and high solar activities on human body as well as about simple and effective measures on how to protect themselves and take care about other people. Employees also learn about their rights concerning the working environment, especially if their work involves outdoor activities.

**Summary assessment:** The implemented programmes have proved to be efficient; the content of training courses and campaigns is tailored with reference to the target audience. Moreover, by definition, the costs of prevention are much lower than the ones of cure.

**Conclusion regarding transferability:** these specific communication strategies are easily transferable.

**Name of challenge:** ***Droughts and water efficiency***
**Cluster of measures:** ***Policies for water saving (7)***

**Applied in:** Zaragoza (ES) and Bologna (IT)

**Climate change challenge:** drought and water efficiency; water quality

**Sector:** water resources management; energy supply and consumption

**Adaptation objective:** raise awareness and improve the information base; coping with extreme events (droughts); decrease water demand

**Related to management step:** implementation and monitoring

**Type of instrument(s) used for implementation of measure:** regulatory and communicational instruments

**Description:** in most countries, people have recognized the growing water scarcity problem; water efficiency, while not yet a major priority in the agendas of governments, has been a growing concern. Global organisations like the World Water Council, the International Water Management Institute, and UNESCO have been promoting water efficiency (it focuses on reducing waste, obtaining the desired result or level of service with the least necessary water) alongside water conservation (it focuses on restricting its use).

**Summary assessment:** the biggest challenge remains to get citizens to believe that climate change adaptation is a major and urgent issue. New building codes have been approved in both cities in order to promote the usage of water-efficient technologies and devices in new houses and the installation of rainwater collection systems.

**Conclusion regarding transferability:** the appropriate implementation solution for these measures is through the introduction of changes to the building regulations, which may be transferred from other local governments depending on the country's political system. There is little innovativeness in this measure, but an overarching approach – led by a determined administrative body and a strong political support - is however crucial. A sense of urgency can trigger successful outcomes.

**Name of challenge:** ***Droughts and water efficiency***
**Cluster of measures:** ***Building retrofitting (8)***

**Applied in:** London

**Climate change challenge:** Droughts and water efficiency; River floods; Intense precipitation, drainage and flash flooding; Heat waves and urban heat islands

**Sector:** energy supply and consumption; building and construction; water resource management; health impacts (indirectly)

**Adaptation objective:** to raise awareness and improve the information base; to reduce risk and sensitivity

**Related to management step:** Political commitment; implementation and delivery

**Type of instrument(s) used for implementation of measure:** mainly fiscal instruments

**Description:** the approach foresees the implementation of water and energy saving measures such as shower timers and different shower heads. The spread of information on climate change impacts such as urban heat island effect, flooding and overheating should be among the major goals of the measure as well, in order to raise awareness and improve the information base.
**Summary assessment:** the measure aims to improve the water and energy efficiency of homes while reducing vulnerability to drought and contributing to a sustainable, climate resilient city; it uses innovative technology to meet ambitious targets, and its success will be dependent on continued political backing.

**Conclusion regarding transferability:** these measures should not be seen simply as a response to climate change; the principle of water efficiency is central to sustainable cities and they should be embraced in any European city and in any social context.

**Name of challenge:** ***Droughts and water efficiency***
**Cluster of measures:** ***Securing drinking water resources (9)***

**Applied in:** Dresden

**Climate change challenge:** Intense precipitation, drainage and flash flooding; Drought and water efficiency; Water quality

**Sector:** Water resource management

**Adaptation objective:** Reduce risk and sensitivity; Coping with extreme events

**Related to management step:** Implementation and monitoring

**Type of instrument(s) used for implementation of measure:** Regulatory instrument; planning instrument

**Description:** A new drinking water protection area has been designated to ensure sufficient future drinking water supply.

**Summary assessment:** The designation of a new drinking water protection area in Dresden is a precautionary measure to increase resilience against potential shortages of supply, as well as a potential increase in demand. Temporary supply shortages may occur more frequently in the future due to climate change (low river tides limiting available amount of river water; heavy rainfalls causing temporary disruptions of supply from barrages). In addition, higher summer temperatures may lead to increased peak demands at periods of low supply.

The measure is already associated with some costs (land acquisition, groundwater monitoring) but these are small in relation to investment costs for the construction of wells; the latter will only occur if future assessment of climatic and socio-economic development shows a need for it. Side effects are relatively small (positive: high level of environmental protection for the concerned area; negative: restrictions on land use and economic activity for local residents and businesses). Early designation of additional areas of water supply may help avoid future costs and land use conflicts.

**Conclusion regarding transferability and lessons learnt:**
The challenges addressed by the measure are common. However, the need for such measures and the possibilities for their implementation depend on numerous location-specific factors, e.g.: expected future development of water supply and demand; availability of suitable land and water resources; legal instruments at national, regional and local levels.

**Name of challenge:** ***Biodiversity loss***
**Cluster of measures:** ***Biodiversity strategy (10)***

**Applied in:** Zaragoza (ES)

**Climate change challenge:** biodiversity loss

**Sector:** soil protection and biodiversity conservation; protection of green spaces; tourism and leisure activities

**Adaptation objective:** reduce risk and sensitivity

**Related to management step:** baseline review and vulnerability assessment; implementation

**Type of instrument(s) used for implementation of measure:** regulatory instruments

**Description:** The measures focus on protecting the fauna and flora of the municipalities; in Zaragoza the emphasis is on a plan to protect the steppe and to control invasive species which are having a devastating effect on the endemic ones.
**Summary assessment:** biodiversity is important in all ecosystems, not only in those that are "natural" such as national parks or natural preserves, but also in those that are managed by humans, such as farms and plantations, as well as urban parks. Biodiversity is the basis of the multiple benefits provided by ecosystems to humans; its loss has negative effects on several aspects of human well-being, such as food security, vulnerability to natural disasters, energy security, and access to clean water and raw materials. It also affects human health, social relations and freedom of choice.

**Conclusion regarding transferability:** The peculiar geographical and biological characteristics of different areas make the transferability of the measures naturally low. Biodiversity protection in Zaragoza is conducted as a combination of measures planned and implemented based on precise evolving needs. Conceived as a reaction to a situation considered urgent, key measures have gradually shaped to form a strategy (an adaptation strategy). Some measures are foreseen to both ameliorate the present situation, as well as to bring additional benefits, such as ecotourism activities and related income.

**Name of challenge:** ***Biodiversity loss***
**Cluster of measures:** ***Capacity building for fire workers (11)***

**Applied in:** Tatabánya (HU)

**Climate change challenge:** Wild fires; biodiversity loss; heat waves; droughts

**Sector:** Civil defence; forestry; soil protection

**Adaptation objective:** To prevent the damage from wild fires and the biodiversity loss; to prevent damages and to build capacity

**Related to management step:** implementation and monitoring

**Type of instrument(s) used for implementation of measure:** development of the protocol of action

**Description:** the frequency of wildfires (uncontrolled fires) in forests and other vegetation sites (wildland fires) has increased in Hungary over the past decade. As long as the increased amount of wild fires is associated with heat waves, the frequency of which is also growing, a protocol of action for the fire brigade has been established and trainings are taking place. The measure seeks to prevent the damage from the wild fires and biodiversity loss and to prevent casualties among fire fighters due to a lack of training and capacity.

**Summary assessment:** the efficacy and usefulness of the measure has been proven. Practitioners and scientists indicate that in Hungary a special fire weather index or a fire weather forecast is not available; the existence of such kind of indicator would increase the ability to operate of the firefighters.
The municipality believes the benefits will clearly outweigh the costs, since prevention is by definition less costly than cure.

**Conclusion regarding transferability:** the specific measure can be easily transferred to municipalities with forests and other vegetation sites on its territories.

**Name of challenge:** ***River floods/sea level rise***
**Cluster of measures:** ***Flood risk mapping and flood alert systems (12)***

**Applied in:** Venice (IT), Prague (CZ), Riga (LV), Almada (PT)

**Climate change challenge:** sea level rise; river floods; intense precipitation

**Sector:** flood and coastal zone management; emergency; building and construction; water resources management; urban and regional planning

**Adaptation objective:** raise awareness and improve the information base; monitor extreme weather events; to safeguard cities from flood damages

**Related to management step:** vulnerability assessment; implementation and monitoring

**Type of instrument(s) used for implementation of measure:** planning and regulatory instruments; public procurement; monitoring and communicational instruments

**Description:** flood alert systems provide flood warning information to citizens, allowing them to protect their houses and businesses. The measure provides adaptation mostly in terms of reducing the impacts of sea level rise.

**Summary assessment:** measures need to be customised for each specific case. In Venice, for instance, the "Tide Centre" allows constant monitoring of sea level and meteorological events, thus providing a valuable instrument for climate change adaptation. High tides are predicted and monitored, with forecasts published daily online and in the local newspaper. Information is also available by telephone, text messages and via electronic displays around town. The information listing provides the twice-daily times of high tide and low tide along with the predicted height of water. When high level is predicted, sirens will sound a warning 3-4 hours in advance of high tide, warning residents to prepare homes/commercial activities.

**Conclusion regarding transferability:** The measures are normally specifically adapted to the meteorological situation of each city and are therefore not directly transferable.

**Name of challenge:** ***River floods/sea level rise***
**Cluster of measures:** ***Movable barriers (13)***

**Applied in:** Prague (CZ)

**Climate change challenge:** river floods

**Sector:** emergency; building and construction; water management

**Adaptation objective:** to reduce risk and sensitivity; to cope with extreme events

**Related to management step:** vulnerability assessment; implementation and monitoring

**Type of instrument(s) used for implementation of measure:** public procurement; monitoring and communicational instruments

**Description:** the measure seeks to safeguard cities from flood damages (destroyed buildings and infrastructure objects, threats to public health because of flood water access into the sewage system) and to preserve the cultural inheritance of the historic city centres.

**Summary assessment:** In reference to the city of Prague, it is possible to say that the system is already in place and works efficiently. The city centre was successfully protected by the movable barriers in August 2002 (though unfortunately the rest of the city was damaged) when the water flow volume exceeded 5000 $m^3/s$.

**Conclusion regarding transferability:** The designing of flood defence systems requires extensive preparation and expertise. Movable barriers can be a solution in a number of cities whose centres, representing high cultural values, are under floods threat. The measure is not really innovative; the idea of movable barriers has been transferred from the city of Cologne, Germany.

**Name of challenge:** ***Intense precipitation***
**Cluster of measures:** ***Water storage and drainage systems (14)***

**Applied in:** Copenhagen (DK), Dresden (DE), Bologna (IT)

**Climate change challenge:** River floods; intense precipitation, drainage and flash flooding; water quality; drought and water efficiency; biodiversity loss

**Sector:** water resources management; health; soil protection and biodiversity conservation; protection of green spaces; urban and regional planning; tourism and leisure activities

**Adaptation objective:** reduce risk and sensitivity; coping with extreme events (floods and droughts); raise awareness through studies and information campaigns

**Related to management step:** political commitment; implementation and monitoring

**Type of instrument(s) used for implementation of measure:** Fiscal and regulatory instruments, as well as voluntary agreement when possible

**Description:** the measures focus on reducing the risk of extreme events such as floods and droughts and on reusing rainwater as a resource, instead of getting rid of it as soon as possible.

**Summary assessment:** work is ongoing to introduce instruments where local management of water can use the rainwater as a resource. Sustainable Drainage Systems (e.g. reservoirs, green roofs, permeable paving, the creation of more green and blue elements in the city), for instance, apart from absorbing and storing a large amount of the water, will also have a number of other advantages (reduce the temperature in the city, create a better indoor climate, offer a living habitat to plants and animals, as well as offering additional recreational spaces). New building regulations should be effective in ensuring that new and existing building developments are better protected from floods and capable of storing rainwater, through the implementation of water storage volumes.

**Conclusion regarding transferability:** the numerous past and ongoing experiences in relation to the above mentioned measures in Europe, demonstrate the high potential of transferability of the above-mentioned measures. This does not mean, of course, that these instruments do not require an extensive preparation, expertise or a legislative and cultural context keen on adopting innovative solutions.

**Name of challenge:** ***Intense precipitation***
**Cluster of measures:** ***Rainwater management (15)***

**Applied in:** Hamburg (DE)

**Climate change challenge:** intense precipitation, drainage and flash flooding; river floods.

**Sector:** Water resource management, urban and regional planning, building and construction, transport, finances and insurance, social life and neighbourhood management, emergency planning.

**Adaptation objective:** Reduce risks and sensitivity (and improve the information base), raise awareness and improve the information base.

**Related to management step:** implementation and monitoring.

**Type of instrument(s) used for implementation of measure:** Communicational / Awareness raising, planning.

**Description:** Hard and soft measures are included in this cluster. On one hand, it seeks to develop responses to avoid flooding of city infrastructure and water overloading through maintaining drainage and improving water protection and inland floods protection. The soft measures are delivered through communication and awareness raising among the population.

**Summary assessment:** Rainwater management is a critical issue in urban areas. Joint planning and development of implementation guidelines is needed involving all relevant administrative actors (traffic and water planning, urban and landscape planning, urban water management and cross-cutting sectors). A commonly agreed, binding and integrated rainwater management can help to implement cost-effective measures at a wider area. Combining these measures with a wide-reaching citizen communication strategy is likely to combine to deliver added benefits.

**Conclusion regarding transferability and lessons learnt:** Joint planning for municipal adaptation measures is key for effective implementation. Near-natural rainwater management is most efficient in areas threatened by flood risk (from smaller rivers) and areas facing an increase of soil sealing. Implementing communication strategies is easily transferable.

**Name of challenge:** ***Overarching***
**Cluster of measures:** **Adaptive urban development** ***(16)***

**Applied in:** Stockholm (SE)

**Climate change challenge:** River floods; Intense precipitation, drainage and flash flooding; Heat waves / urban heat islands; Biodiversity loss

**Sector:** Health; Social life and neighbourhood management; Flood and coastal zone management; Water resources management; Soil protection and biodiversity conservation, protection of green spaces; Urban and regional planning; Building and construction; Transport; Energy supply and consumption; Regional/Local economy

**Adaptation objective:** Reduce risks and sensitivity

**Related to management step:** implementation and monitoring.

**Type of instrument(s) used for implementation of measure:** Planning.

**Description:** Development or redesigning of residential and/or commercial urban areas that incorporate energy efficiency and adaptation measures, or adapt to deteriorating conditions.

**Summary assessment:** As they normally require important infrastructural work, these types of projects are of a long-term character. Strong political commitment is crucial, as investment is often considerable. Agreements with the private sector to reduce public fund expenditures can contribute to the materialisation of the project. Involvement of internal and external stakeholders (e.g. builders, citizens) as active participants is necessary in order to develop a sense of shared project ownership from the start.

**Conclusion regarding transferability and lessons learnt:** These measures are, by concept, easily transferable, but they require strong, long-term political commitment and public and private investment. A holistic approach (e.g. from joint discussion with industrial players located in the area, to planning for soil remediation, to early-stage stakeholder involvement, etc) is likely to help projects evolve with strong foundations.

**Name of challenge:** ***Overarching***
**Cluster of measures:** ***Vulnerability assessment (18)***

**Applied in:** Helsinki (FI), Manchester (UK)

**Climate change challenge:** Overarching. Different focus depending on place of implementation.

**Sector:** Overarching.

**Adaptation objective:** Reduce risks and sensitivity, raise awareness and improve the information base.

**Related to management step:** implementation and monitoring.

**Type of instrument(s) used for implementation of measure:** Planning, communicational.

**Description:** Development of blueprints or scenarios to guide local authorities in the preparation of an adaptation strategy. These tools can become a key resource for planners and other relevant stakeholders in the city/region as they seek to adapt to climate change.

**Summary assessment:** Climate change scenarios and guidelines are instrumental in developing an overall adaptation strategy that would ensure integrated climate adaptation management. The process for developing scenarios for a given region can be relatively cheap as long as relevant data exists. It is likely to deliver information needed for designing future activities and is also useful in improving current practices.

**Conclusion regarding transferability and lessons learnt:** While climate change scenarios are valid only for the region of focus, the methodology used can be applied for any location. Guidelines (or blueprints) are a less technical, but more easily to disseminate tool. A combination of the two would provide a strong foundation for developing an overarching adaptation strategy.

**Name of challenge:** ***Overarching***
**Cluster of measures:** ***Comprehensive inclusion of adaptation concerns in municipal processes (19)***

**Applied in:** Tatabánya (HU)

**Climate change challenge:** Overarching.

**Sector:** Overarching.

**Adaptation objective:** Umbrella plan to deliver improved quality of life to citizens.

**Related to management step:** Baseline review, target setting, political commitment, implementation and monitoring.

**Type of instrument(s) used for implementation of measure:** Planning, voluntary agreement.

**Description:** In the case studied, the bottom-up and top-down approaches meet. The national Hungarian government encourages the creation of the regional and local climate action strategies and plans. The initiative of Tatabánya was prepared with extensive stakeholder participation. It is an integrated approach addressing both mitigation and adaptation.

**Summary assessment:** The implementation of umbrella strategies requires regular monitoring by the municipality and 3rd party verification. Targets should be studied and possibly revised to maintain sensible and, at the same time, challenging goals. A cross-sectoral, collaborative approach is mandatory.

**Conclusion regarding transferability and lessons learnt:** Political will is crucial in the preparation of an overarching adaptation plan, as well as willingness by different departments of the local authority to work together. Stakeholders should be incorporated into the plan at an early stage.

# 5. Recommendations

The recommendations outlined in this chapter are aimed at city administrations who wish to design, implement and evaluate adaptation strategies and key measures to address specific climate change challenges in their city. The recommendations are based on lessons learned from best practice, building on the current literature on adaptation in cities, and experiences identified in the case studies.

This chapter is structured using the following headings:

**Recommendations for city adaptation strategies**
This section explores how each of the success factors identified in the literature review is being applied in the development of overarching adaptation strategies across Europe. Where applicable, the findings from the case study interviews are put into the context of the integrated management cycle[23], a useful five-step guide to planning an adaptation strategy shown below.

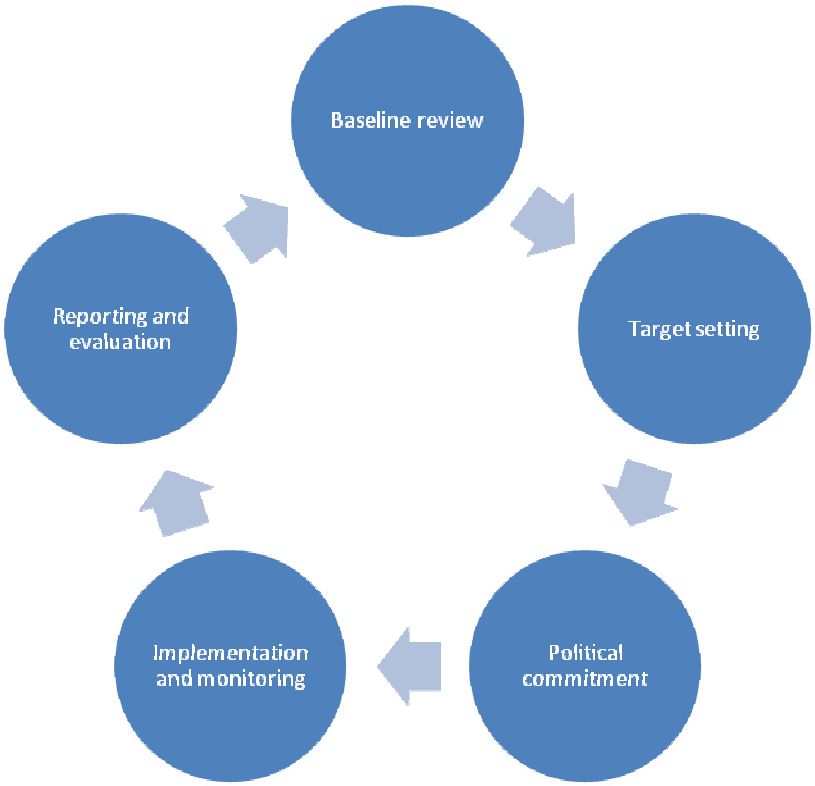


**Figure 3: Integrated management cycle**

[23] The 5-step integrated management cycle has been developed by ICLEI. It is an environmental management system (EMS) which has served as a guide to cities' implementation of the Aalborg Commitments (http://www.localsustainability.eu/index.php?id=4269)

**Recommendations for specific measures to address climate change challenges**

This section explores clusters of measures which can be used to address the following specific climate change challenges (identified in Chapter 4):

- Loss of biodiversity
- Overarching
- Urban heat island effect and heat waves
- Drought and water efficiency
- River floods and sea level rise
- Intense precipitation

Key measures for each climate change challenge are presented in a matrix which allows the reader to identify which stage of the integrated management cycle the measure corresponds to. If a city needs to conduct a baseline review, for example, it is clear at a glance which measures may be applicable.

The measures discussed in this chapter vary widely in terms of the resources needed for implementation. Some are more suitable for cities that already have significant political backing to undertake adaptation, whereas others can be implemented with little input from government. Some measures require intensive evidence gathering through the use of scenarios and tools, whilst others are more straight-forward. Stakeholders, time, budget and technical expertise are other factors which affect the transferability of a measure. It is intended that this chapter will allow readers to identify the most suitable measures for their city.

## 5.1. Recommendations for city adaptation strategies

This section explores how each of the success factors identified in the literature review is being applied in the development of overarching adaptation strategies across Europe. Where possible they are placed into the context of the integrated management cycle outlined above.

The five success factors essential to effective adaptation strategy planning and implementation in cities are:

- Leadership
- Stakeholders
- Information and knowledge
- Adaptation as learning
- Tools and guidance

As a first step, it is important to consider the key drivers that might instigate the development of a city-wide adaptation strategy (Figure 4). These can be useful issues to consider when putting forward a case for creating an adaptation strategy and trying to gain political commitment. For instance, you might consider your answers to the following questions: 'What is the city's current vulnerability to climate impacts and extreme weather?' and 'what is the cost to the city government of 'business as usual' versus taking action now?'


**Figure 4: Drivers for a city wide adaptation strategy**

Based on the analysis of city adaptation strategies from across Europe, a number of factors have been identified to help develop new, and improve existing, city adaptation strategies. These are illustrated in Figure 5 below and discussed in more detail in the coming section.


**Figure 5: Enabling factors for a city wide adaptation strategy**

**Guidance and leadership**

Strong leadership is critical for adaptation planning in cities. This can be made easier by the involvement of researchers or think tanks, giving confidence and momentum to leaders and stakeholders (Lonsdale et al, 2009). A lack of political commitment in cities due to a sense of 'no urgency' is a key challenge to overcome when developing a city adaptation strategy.

The case studies identify varying types of leadership in European cities. Leadership by municipal governments can be contrasted with leadership by the research community, but sometimes the most effective approach is leadership which benefits from guidance from government *and* the research community. In Manchester, for example, the University has a close working relationship with the City Council which provides a useful cross over between academic research and policy. However, the University has independently sought funding and undertaken research into climate change and adaptation in the region. The significant input to adaptation from the University has been bolstered by emerging legislation and guidance from the UK Government on adaptation, most notably National Indicator 188 (see Annex 2).

Conversely London's Climate Change Adaptation Strategy is driven very much by the city government, the Greater London Authority (GLA). The city benefits from having strong political leadership on climate change and thus there is less reliance on the academic community to drive forward the adaptation agenda. In this way the GLA leadership provides a 'demand' for adaptation knowledge at the city level. In addition to strong leadership, the GLA still works frequently

with the research community, for example with Brunel University to promote 'cool roof' technology, highlighting the need to build links between decision makers and researchers. The London Climate Change Partnership (LCCP) has also commissioned research projects to provide an evidence base for adaptation in the city.

The 'demand-led' approach seen in London can be contrasted with the information 'supply-led' approach seen in Manchester. In London, strong political leadership has created a demand for adaptation knowledge and the GLA Act (a local Act outlining the Mayor's powers and responsibilities) has put an onus on the Mayor to take action on climate change. Conversely, in Manchester there is a significant body of adaptation research available and underway, but the city adaptation strategy has not yet been developed. This is likely to be down to the lesser 'demand' to use this knowledge in Manchester as opposed to London; there is no equivalent of the GLA Act in Manchester.

Elsewhere, partnerships between city administrations and the research community have led to effective adaptation initiatives. Prague is preparing a city-wide 'Flood Defence Plan' led by Prague City Hall with support from the Czech Technical University, Brno University of Technology and the TG Masaryk Research Institute for Water Management. The technical expertise provided by the academic community provides the city government with the confidence it needs to take forward its Flood Defence Plan, making it easier to maintain momentum during the implementation phase. Similar collaborative relationships exist in other cities, for example between the city of Stockholm and the KTH Royal Institute of Technology.

**Stakeholders**

Adaptation is a 'process of dialogue' (Lonsdale et al, 2009: 22), which is important to maintain at all stages, from gaining political buy-in to implementing adaptation measures and ensuring the strategy is monitored and kept up to date. The case studies highlight that the early involvement of stakeholders and residents is important for best practice adaptation in cities. In London, where the adaptation strategy is undergoing the second phase of public consultation, a website has been set up to encourage public and stakeholder comments on the strategy and future actions. This is a simple and cost effective way of encouraging stakeholder involvement and ownership. There is also a stakeholder working group co-ordinated by the LCCP which shows that stakeholders have a role beyond just consultation.

In Tatabánya, Hungary, stakeholders involved in the development of the strategy included local police, disaster recovery, schools, hospitals, as well as the National Alliance of Climate Friendly Cities. The benefit of such extensive

stakeholder engagement has been the meeting of the top-down and bottom-up approaches. For example, a group of local enthusiasts within Tatabánya's local government convinced the city council that adaptation and mitigation should be part of an integrated climate change strategy. This demonstrates the power of involving people who are passionate about the subject area and the benefits of multi-stakeholder working in designing adaptation measures.

**Information and Knowledge**

In order to create knowledge about the risks and opportunities of climate change, climate and non-climate information must be available to cities. This includes best practice examples from other cities as well as climate projections, socio-economic scenarios and information on past events. Specific tools for exploring these factors are discussed under the sub heading 'Tools and Guidance'.

Some decision-makers feel immobilised by the complexity of climate change information, or the (perceived) lack of detailed or robust data on how impacts will be experienced at their local level.

Awareness raising is an important feature of adaptation planning, implicit at every stage in the integrated management cycle. Awareness raising is best achieved through the use of information and knowledge suitable for the end user (Nottingham Declaration, N.D; CAP, 2007; Lonsdale, 2009). In Lyon, a local climate assembly will be held in order to enable dialogue and consultation between public and private sector stakeholders. This will create a climate adaptation working group which, it is hoped, will allow a more joined up approach to be taken in the development of Lyon's Adaptation Strategy.

Stockholm is in the early stages of developing its adaptation strategy, and at present carries out annual risk and vulnerability assessments. This is a quick and effective way to develop a city-wide evidence base for an adaptation strategy in the longer term, particularly where there is a lack of defined guidance from central government. This approach can be a useful way to raise awareness amongst city residents of the risks and opportunities posed by climate change. In Zaragoza, Spain, regionally specific reports by the State Agency of Meteorology and of the Hydrographic Confederation of the River Ebro were used to inform vulnerability assessments.

The 'oversupply' of adaptation information can, however, be counterproductive. Where there is an over-supply of information, but no 'demand' for that information (i.e. no decision makers who have a need to apply that information) then it is unlikely that adaptation measures will be implemented. Information overload is a potential barrier identified in the literature review; Lonsdale (2009)

states that information must be converted into knowledge. This links into the concept of adaptation as a learning process; it is not purely a data analysis exercise.

**Adaptation as Learning**

The literature review identified the theme of 'adaptation as learning', whereby adaptation is an iterative process requiring – in addition to information and knowledge – space and time for innovation, training of staff and stakeholders and a learning atmosphere where honest reflection is encouraged.

Sufficient resources must be available if this process is to be effective. In Sweden, the central government has granted overarching responsibility for the coordination of regional adaptation strategies to the country's 21 administrative boards, of which Stockholm is one. However, this puts a lot of pressure on the municipalities who are expected to deliver an adaptation plan. Whilst there are benefits to this kind of bottom-up approach, including better knowledge of local conditions and threats, smaller municipalities have only limited resources, expertise and funding to develop and implement these plans. To overcome this, municipalities might work together to share their resources, whether financial, institutional or knowledge based.

It is vital that city adaptation strategies are constantly evolving and improving, as well as reflecting new information and climate science. This is demonstrated by London's desire to obtain views from the public and stakeholders on ways to measure the progress of its adaptation strategy. The consultation portal mentioned above seeks views on possible indicators and ways to monitor progress. The fact that London's Strategy has been drafted and consulted on several times demonstrates 'learning in action'.

**Tools and Guidance**

Central to the development of city-level adaptation strategies is the availability of tools and guidance documents to help decision makers prepare to adapt to the impacts of climate change (see Annex 2). The case studies show that the most widely used tools in the development of city adaptation strategies are regional climate change scenarios, risk assessments and modelling, impact and vulnerability assessments and mapping tools, as well as cost-benefit analyses.

Birmingham and London's Climate Change Adaptation Strategies have been informed by many of the UK Climate Impacts Programme tools. In both instances, the UKCP09 climate projections were used in conjunction with a Local Climate Impacts Profile which assesses vulnerability to recent, extreme weather events. Local vulnerability assessments are a common way to establish

current vulnerability to climate impacts at the city level. The LCLIP is recommended as a simple, cost effective method for assessing at a high level, vulnerability to extreme weather events.

Many of the city adaptation strategies were informed by the IPCC SRES scenarios, which were then downscaled and regionally applied according to local conditions (see for example, Copenhagen, Vienna, and Helsinki). In Helsinki, the Finnish Meteorological Institute provided regional climate scenarios to inform the 'Helsinki Metropolitan Adaptation Strategy' whilst the Finnish Environment Institute is providing river models for two rivers that run through the city. In Vienna, an assessment of the future flow of the River Danube was conducted.

Amongst the more specific needs for tools and guidance were locally adapted indicators of climate change risk. For example, in Tatabánya, Hungary, it was identified that a fire weather index or fire weather forecast would increase the ability of firefighters to prepare and respond to wild fires.

When planning for adaptation, the following questions and recommendations should be considered. These are based on the five key success factors discussed above.

**Table 9: Questions to help cities apply the five key success factors in adaptation planning**

| Questions | Recommendation for the city |
|---|---|
| Are there any political, regulatory or legislative drivers of adaptation in your city? | Identify the policy and legislation which is relevant to adaptation in your city. This might not be branded as 'adaptation' but could include strategies for sustainable water management or conservation of biodiversity, for example. Use this legislation to gain buy-in from other partners to take adaptation forward. |
| Is adaptation planning part of a municipal government strategy or part of a research programme? | Aim for balanced leadership. City government strategies will benefit from input from research, as well as private industry. Try to link up research-led initiatives with officials at the city level. |
| What existing information and knowledge on adaptation do you have access to in your city? | Consider building relationships with research institutions in the city to allow sharing of good practice and the latest adaptation knowledge. |

| | |
|---|---|
| Is there an imbalance in the supply of adaptation knowledge and the demand for using that knowledge? | Information overload is a potential barrier to developing an adaptation strategy and identifying key adaptation measures, particularly if there is little demand for it. Supply and demand should be balanced. Put in place requirements for people to use climate change knowledge. |
| Do you have access to tools and guidance in your language that apply to your circumstances? | Tools and best practice guidance will help to identify which measures would be best suited to your city, based on successes in cities of similar size, culture and climate. Identify tools and guidance and use them. |
| How much political backing do you have at the city level? | Build an evidence based case outlining why adapting to climate impacts is important for the city. Meet with senior politicians to gain buy-in as early on as possible. |
| What budget do you have to implement adaptation measures? | Implement measures which are in proportion to your budget. There are simple yet effective measures which can be put in place even where budget is limited. |
| Do you have a stakeholder forum which brings together public, private and academic institutions as well as the wider community? | Try to build a network or partnership of stakeholders to be involved in adaptation planning and implementation. |

## 5.2. Recommendations for adaptation measures to address climate challenges

### Biodiversity

**Table 10: Key measures for addressing biodiversity loss in cities and their relation to the management cycle**

| Management step / Measure | Baseline review | Target setting | Political commitment | Implementation and monitoring | Reporting and evaluation |
|---|---|---|---|---|---|
| **Biodiversity strategy, Zaragoza** | | | | | |
| **Capacity building for fire workers, Tatabanya** | | | | | |

**Success factors**

- **Political will** is crucial to the success of both measures. For example Zaragoza's biodiversity strategy is driven by the city-wide overarching Strategy for Adaptation to Climate Change. The Strategy is funded via the municipal budget and led by the Environmental and Sustainability Agency of the Municipality of Zaragoza;
- **Adaptation as learning.** Capacity building amongst firefighters in Tatabánya is a successful way of using adaptation as an educational tool. Similarly Zaragoza's biodiversity strategy was developed using the budget for Environmental Education and Climate Change on the municipal level, demonstrating support for adaptation as a learning process;
- **Early stakeholder involvement** and **cross sector working** between municipal authorities and research institutions played a large role in driving Zaragoza's biodiversity strategy. There was much support for capacity building from the Municipality of Tatabánya, as well as from the academic community through the Sociological Research Institute of the Hungarian Academy of Sciences.

**Cost and benefits**

Tatabánya's approach to capacity building amongst firefighters is a straightforward yet effective communicative measure to help avoid losses in forestry and green space. The benefits are very likely to outweigh the costs

because capacity building is in order of magnitude cheaper than the average costs of fire damage and lost ecosystem services.

In Zaragoza, the more integrated approach to climate adaptation management brings benefits in terms of alleviating already existing environmental problems. These include social benefits such as conservation of green areas, increased quality of life and economic benefits such as eco-tourism. While it is hard to put a value on the benefits of protecting biodiversity, it is likely that the benefits in the long-term will outweigh the costs. This is a useful example of how to integrate adaptation into wider sustainability initiatives.

**Transferability**

The process of capacity building amongst firefighters can be easily transferred to cities and municipalities with forests and other vegetation sites on or close to its territories. It is a **simple, communicative measure which is effective in a short timescale with low costs**. An added benefit would be the introduction of a fire weather index which would increase the ability of fire fighters to operate.

Conversely, the creation of a biodiversity strategy has lower potential for transferability as it **requires a lot of city-specific information** which can be time consuming and costly to gather. The geographical characteristics of Zaragoza are unique and would need to be assessed and adapted for other cities. A high level of expertise in local biodiversity and ecosystems is required to correctly identify the necessary actions and solutions.

If your city has significant political backing, local ecological knowledge, time and funding, a biodiversity strategy is an effective means of integrating climate impacts. If you have less funding and support, building capacity among citizens about the risk of wild fires and other climate impacts is a simple and cost-effective measure to implement.

## Overarching measures

### Table 11: Key measures for addressing overarching issues in cities and their relation to the management cycle

| Management step / Measure | Baseline review | Target setting | Political commitment | Implementation and monitoring | Reporting and evaluation |
|---|---|---|---|---|---|
| **Residential and commercial urban area, Stockholm Royal Seaport** | | | | | |
| **Development of climate change scenarios for Helsinki Metropolitan area** | | | | | |
| **Manchester EcoCities adaptation blueprint** | | | | | |
| **Mitigation efforts to reduce adaptation needs in Zaragoza** | | | | | |
| **Comprehensive inclusion of adaptation concerns in municipal processes, Tatabanya** | | | | | |

### Success factors

- **Stakeholders should relate to the sustainable philosophy of the measure.** As seen in Stockholm, early stakeholder buy-in creates a sense of ownership and increases the likelihood that city residents will support the measures being put in place.
- **Adopt a holistic approach to adaptation.** As Stockholm's urban development shows, a holistic approach to adaptation targeting two or more issues at once can be just as effective as a direct adaptation measure. In Stockholm, the demand for housing and office space provided an opportunity to incorporate adaptation measures in buildings, reducing vulnerability to increased rainfall, flooding and the urban heat island effect.
- **Adaptation should be seen as an auxiliary benefit of a wider sustainability measure**. Zaragoza's renewable energy strategy is not seen to contribute directly to integrated climate change adaptation, but it has side-benefits for adaptation, including improved local air quality and reductions in the over-use of resources.
- **Collaborate between research institutions and policy makers and practitioners** to plan for city-wide adaptation. In Helsinki, the development of scenarios was made easier thanks to both city and metropolitan area being involved in the BaltCICA research project. The

project provided funding, expertise and the opportunity to exchange experiences with other cities.

**Cost and benefits**

Stockholm expects its urban development to positively impact existing social, environmental and economic problems while taking into account the need for flood management and green spaces in response to projected climate impacts. This demonstrates that adaptation can be integrated into ongoing development; it does not always need to be tackled as a stand-alone issue.

In Zaragoza, there have been institutional barriers in the development of the renewable energy strategy including getting departments within the city government to work with each other. Faced with this challenge, ensuring the coordination of measures can be time-consuming and reduce cost-effectiveness. This emphasises the importance of having political backing and good governance from the start.

The process of developing city-wide climate change scenarios in Helsinki has been cost effective since the scenarios are based on existing data. The success of this measure can be attributed to the strength and decision-making power of the Helsinki local government, a feature of many Nordic local governments.

EcoCities in Manchester is a rare and innovative approach to planning for adaptation in cities. The measure demonstrates the value of research institutions working with the private sector to plan for adaptation. Manchester University and Bruntwood Property Managers are working together to develop guidance for stakeholders to develop adaptation strategies and implement adaptation measures. This cross-sector working will lead to local economic benefits as Bruntwood gain knowledge on how to reduce the vulnerability of their properties and business operations to a changing climate.

**Transferability**

The success of Stockholm's urban development is not dependent on geographical conditions. Providing a city has **strong institutional structures** and an authority that is prepared to work with other levels of government, the measure has potential to be transferred simply and effectively. New urban developments are best applied to cities with well developed spatial plans, government funding and forums for stakeholder engagement. If your city has good sustainable building regulations, these can focus the need to integrate adaptation measures.

Helsinki is the only large urban area in Finland and finds national guidance more difficult to apply as it is aimed at smaller towns. As such Helsinki finds

more value in **exchanging best practice with similar European cities** such as Hamburg, which is also a large city near the coast.

The development of regional climate change scenarios is most practically achieved through **working with climate science research communities** to share knowledge and expertise. For cities with limited expertise in climate change impacts as well as limited funding, sharing adaptation best practice guidance with similar cities is recommended as a cost effective means of developing knowledge about climate change impacts. Exchanges between cities can occur through existing networks or via participation in European projects.

The conceptual framework provided by EcoCities is transferable to any city in Europe and is best achieved through **interdisciplinary working.** However this is dependent on the willingness of the private sector funder, which is locally specific. A similar measure could be implemented through working with the research community and could therefore be transferred to any city which has an **innovative academic community and/or private sector**.

## Urban heat island effect and heat waves

**Table 12: Key measures to address the urban heat island and heat waves, and their relation to the management cycle**

| Management step / Measure | Baseline review | Target setting | Political commitment | Implementation and monitoring | Reporting and evaluation |
|---|---|---|---|---|---|
| Increasing tree canopy in London, Lyon, Bologna and Tatabanya | | ■ | ■ | ■ | |
| Installing green roofs in London, Manchester, Vienna and Tatabanya | | ■ | ■ | ■ | |
| Building Regulations in Bologna | | | ■ | ■ | |
| Heat Alert System in Tatabanya and Budapest | | | | ■ | |
| Heat threat educational and awareness programme in Tatabanya and Budapest | | | | ■ | |
| Capacity building for fire workers in Tatabanya (see commentary under 'biodiversity') | | | | ■ | |

**Success factors**

- **Strong leadership and political buy-in** have proved to be important when trying to increase the green canopy within cities. The London urban greening programme is a key manifesto commitment for the city authority and is driven by the London Climate Change Adaptation Strategy and the London Plan;
- The Sun Smart Educational Programme of Tatabánya is a measure which can be described as **adaptation as learning**. This win-win, communicative measure effectively teaches city dwellers about the impacts of the urban heat island effect, in a manner that is easy to understand;
- **Incorporation of adaptation measures into wider sustainability initiatives**. In Bologna, the new building regulations introduced a requirement to include many new plants outside new building developments and to use pale coloured roofs to increase albedo.

**Costs and benefits**

In Lyon, increasing tree canopy currently only applies to public spaces managed and created by the Grand Lyon Urban Community. The Urban Community is seeking to involve private bodies and local communes in its second 'Tree Charter'. Manchester City Council has already demonstrated through its green roof programme that there is value in partnering with private companies and industry; over-dependence on private investment should be avoided, however.

In London, an urban greening programme was selected because it was determined to align with the city authority's remit to coordinate measures to address climate impacts, alongside other objectives such as improving quality of life in run-down areas. It is recommended that to kick start the adaptation process, cities select measures which they have the greatest ability to influence.

Bologna's new building regulations include a number of measures to reduce exposure to the urban heat island effect. These are not addressed as a primary concern; rather reducing vulnerability to extreme heat is a side benefit. This highlights the value in integrating adaptation measures into wider sustainable city initiatives, particularly where time and money are lacking.

Use of green roofs and increased tree canopy are no-regret measures which provide multiple benefits to city dwellers. Because of the side benefits, which include reduced noise, improved quality of life and better air quality, in addition to the core adaptive benefit of reducing summer temperatures, acceptance of this measure amongst stakeholders is high in all cities. Additionally, it is relatively

cheap to implement leading to a perception of 'value for money' amongst stakeholders.

**Transferability**

An urban greening programme can be implemented in any European city. The measure does not require extensive expertise; however there are technical constraints to overcome. **Consultation with city planners** is an important factor needed to overcome this challenge and enable discussion on the best locations for planting, the most suitable trees and optimum quantity of trees.

Greening programmes are well suited to cities which have **lots of open space**, whereas green roofs are more effective in cities with **high density offices and houses**. Along narrow streets, flowers and shrubs could provide an attractive alternative to trees.

**Local or regional climate change projections** should be used to inform an urban greening programme. What is average rainfall expected to be in 10, 20 or 30 years time? Is drought or flooding expected to increase in the city? This can help determine which species of tree to plant, and in which locations across the city.

In Budapest, a heat alert system was introduced to increase resilience among the population to high temperatures. The success of this measure depended on **strong political will and stakeholders' cooperation** to develop action plans for each of the organisations involved, and thereafter to maintain momentum to follow the action plans. The activities described in the action plans can be modified in accordance with the local conditions.

A **simple, communicative measure,** such as the Sun Smart Educational Programme in Tatabánya, can be easily transferred at minimal cost to other cities faced with increasing heat waves. The content and the materials should be tailored to the needs of the targeted audience, for instance, is the city highly multicultural? If the answer is yes, the campaign should consider use of multiple languages. The measure is based on the premise that prevention costs less than cure.

## Drought and water efficiency

**Table 13: Key measures to address drought and water efficiency and their relation to the management cycle**

| Management step / Measure | Baseline review | Target setting | Political commitment | Implementation and monitoring | Reporting and evaluation |
|---|---|---|---|---|---|
| **Policies for water saving in Zaragoza and Bologna** | | | | | |
| **Building retrofitting in London** | | | | | |
| **Water storage and drainage systems in Copenhagen, Dresden and Bologna (see also 'intense precipitation')** | | | | | |
| **Securing water resources in Dresden** | | | | | |

### Success factors

- **Early community engagement through varied techniques** such as information campaigns, have been critical in the success of water saving policies in Zaragoza. Stakeholder involvement actions were formally conducted encouraging citizens' inputs and welcoming debate. Community engagement must be central to adaptation planning to inform citizens of the impacts of climate change and the city's vulnerability to them.
- A key challenge is **getting citizens to believe and understand that water efficiency is an urgent issue**. This highlights the need for education and awareness raising. The dissemination of information on water efficiency to London residents is an example of how to engage and get the community on board. This is essential to implementing adaptation measure and maintaining momentum.
- The case of Zaragoza shows that **relative urgency can trigger a successful outcome**. As the quality and availability of water in Zaragoza are both poor, actions have been implemented on many fronts and the combination has proved successful. It is recommended that awareness raising takes place in the city to highlight the necessity to adapt to specific impacts of climate change. Information should be relevant and should not overwhelm the city community.
- In Copenhagen, the expansion of sewers, implementation of green roofs and use of reservoirs to store rain and wastewater, all demand a **legislative and cultural context keen on adopting innovative solutions**.

A determined lead administrative body and overwhelming political support have contributed to the effective implementation of these measures. Active involvement from several actors (other departments within the city government, universities, business, citizens, NGOs) has also been beneficial.

**Costs and benefits**

The policies for water saving introduced in Bologna do lead to small cost increases for building developers, but these additional costs are considered acceptable to all stakeholders. Benefits include relief from water shortages during droughts and delaying the construction of new reservoirs. The impacts of summer droughts lead to a demand for the City Council to "do something". Similar events in other cities can be used to motivate stakeholders into action.

The retrofitting of homes in London was developed in order to raise awareness of and improve the information base on energy and water efficiency. The cost of the measure is high but it is estimated that the cost of water and energy savings in 1.2 million homes will provide significant cost benefits. There is a potential increased work load for local retrofitting companies, potentially bringing employment benefits.

It is likely that the benefits of sustainable drainage systems in the long term will outweigh the costs of implementation. The measures implemented in Copenhagen foster more integrated climate adaptation and have the potential to bring further environmental and economic benefits. This relates to the need to strive for a 'sustainable city' whereby adaptation benefits arise from wider sustainability initiatives.

**Transferability**

The transferability of measures to reduce vulnerability to droughts and increase water shortages depend largely on **strong institutional governance** to initiate the measure as well as to maintain momentum.

Bologna's water conservation measures are not related to national or regional legislation and should be relatively standard for many Local Governments facing water shortages. They require **little preparation or expertise** in development and consultation and are not demanding in procedures or mandates.

Retrofitting homes and other buildings with water saving technologies, as seen in London, is a measure which can be applied within any regional legislative context or governance structure, providing there is **funding and strong political backing** available to the city. The principle of water efficiency is central to

sustainable cities and installing water saving devices in homes could be embraced in any European city and in any social context, particularly as it provides quality of life benefits, **supporting vulnerable groups** such as the elderly and less well-off.

Past and ongoing experiences with sustainable drainage systems in Europe demonstrate the high potential for transferability of this solution, for example those measures implemented in Copenhagen, Bologna and Dresden. These instruments do, however, still require **extensive preparation and expertise** or a **legislative and cultural context willing to adopt innovative solutions**.

The transferability of measures to secure drinking water areas, as seen in Dresden, depends on **climatic and topographical factors**, land use patterns as well as water demand. To ensure sustainability of water supply, it is important to conduct effective resource monitoring and restrict the amount of water that can be extracted.

## River floods and sea level rise

**Table 14: Key measures to address river floods and sea level rise, and their relation to the management cycle**

| Management step / Measure | Baseline review | Target setting | Political commitment | Implementation and monitoring | Reporting and evaluation |
|---|---|---|---|---|---|
| Flood alert systems in Venice, Prague, Riga and Almada | | | | | |
| Moveable barriers in Prague | | | | | |

### Success factors

- One of the most important lessons learned from Riga's Spatial Plan is that **interaction between scientific developments and policy making should be strengthened to** encourage the use of guidance and tools. For instance, within the research projects ASTRA and BaltCICA, an assessment of the impacts of climate change has been done and the impacts of sea level rise have been modelled. Integration of these assessments in the spatial planning process saves time and money by avoiding duplication of efforts;
- There is no adaptation objective in the Spatial Plan of Riga; however, the Plan recognises the risks of extreme events and coastal erosion, and aims

to safeguard property and infrastructure. This highlights that **adaptation measures are often a positive side effect of other sustainable city initiatives.**

## Costs and benefits

The benefits of the Venice 'Tide Centre' are rated as very high, although could be further improved if more funds were available. The information provided is used by citizens, tourists, businesses and city administration, for example the city environmental services company is putting in boardwalks to make it easier for people to move in the affected areas. This measure does require high levels of funding in order to make it effective, due to the high cost of data. It also benefits from well established relationships with local organisations and meteorological services.

Spatial plans have been put in place in Riga and Almada. Riga's plan does not have a direct objective for adapting to climate change, whereas Almada's Plan aims to reduce risk and sensitivity through the inclusion of climate challenges in urban planning. These two different approaches demonstrate that adaptation measures can be integrated into wider sustainability issues at the city scale or can be the primary focus of a plan or strategy.

In Prague, movable barriers have been introduced in response to flooding in the city. The avoided losses from flooding, including biodiversity and revenue from business and tourism, clearly outweighs the costs of construction and maintenance. The dams of the Vltava provide hydroelectric generation and are also used for recreational purposes. As such, this measure could be implemented in cities short of recreational space.

## Transferability

The Venice 'Tide Centre' is a communicational measure used to impart information on flood warnings to citizens. Information is available by telephone, text messages and via electronic displays around the city. While the measure is specifically adapted to the meteorological situation of the city of Venice, the model can be used as a simple and cost effective way of raising awareness of flood risk in any city, for any climate change challenge. This measure is pertinent to all cities which suffer from flooding, but particularly cities where flood water causes significant damage to cultural and business assets.

Almada's experience of developing a spatial plan demonstrates that it is relatively easy to introduce if there is local political commitment to environmental issues and sufficient funding. Tools and guidance are vital resources for providing city-specific knowledge about climate risks. Spatial

plans do require a lot of evidence upfront and this can be time consuming, so it is important also to have a dedicated group of people, with one champion, who can take this measure forward.

Moveable barriers can be transferred easily to other European cities where flooding threatens business assets and cultural and historic sites. Inspiration for Prague's flexible flood barriers was provided by the city of Cologne, Germany emphasising the **value in sharing best practice between cities**.

## Intense precipitation

**Table 15: Key measures to address intense precipitation and their relation to the management cycle**

| Management step / Measure | Baseline review | Target setting | Political commitment | Implementation and monitoring | Reporting and evaluation |
|---|---|---|---|---|---|
| **Water storage and drainage systems in Copenhagen, Dresden and Bologna (see also 'droughts and water efficiency')** | | | | | |
| **Precipitation educational programme in Budapest and Hamburg** | | | | | |
| **Infrastructural adaptation planning in Hamburg** | | | | | |

### Success factors

- Given the intersectoral focus of water management, it is vital to establish a **commonly agreed, binding and integrated rainwater management strategy** to help implement cost-effective measures at the city level. The City of Hamburg has benefited from joint planning processes in its infrastructural adaptation planning. This includes joint meetings to identify links between different sectors and working groups as well as to identify and overcome barriers to current planning and administrative processes;
- A key success factor for the implementation of infrastructural adaptation planning in Hamburg was **obtaining finance from the City of Hamburg's** Ministry of Urban Development and Environment. This demonstrates political commitment and backing for the measure, factors which are necessary to promote successful adaptation planning;

- **Strong personal engagement** of Hamburg's municipal water utilities was another key success for adaptation planning in Hamburg, as was the integration of private sector-related issues.

**Costs and benefits**

Sustainable drainage systems measures in Copenhagen include building reservoirs to store rain and wastewater, implementing green roofs, and increasing the "green and blue" elements in the city. Benefits in the long-term will outweigh the costs of implementation, as residents understand the impacts of intense precipitation on the city. This measure requires effective stakeholder engagement at the city-level in order to raise awareness of climate impacts and thus the need for such actions.

The designation of a drinking water protection area in Dresden restricts water extraction for private purposes and activities that negatively affect water quality, such as use of fertilizers and other polluting industries. However the negative economic impact is outweighed by the need for good quality drinking water for city residents. Because residents can relate to the need for this measure, implementation is made easier. Again, cities must have stakeholder engagement processes in place to make this measure effective.

In Hamburg, infrastructural adaptation planning is a positive, win-win measure, particularly if it leads to legally binding instruments such as the integration of rainwater management in urban and regional planning. Benefits would include conservation of biodiversity and enhanced quality of life. It is too early to assess the cost benefit ratio of the measure due to its recent implementation; however this type of measure could be effective in cities which have well established cross-government relationships.

**Transferability**

Rainwater management is a concern for all urban areas facing an increase in precipitation due to climate change. Measures to increase resilience to intense precipitation rely on **effective, cross-government working** as water and flooding is a challenge that affects all government departments.

The designation of a drinking water protection area seen in Dresden can be applied to any city. The measure does require stakeholder engagement in order to identify and mitigate any conflicts of interest early on in the design of the measure. The need and potential for securing additional areas for water supply **depends on local climatic conditions, topographical factors, land use patterns and water demand**.

Infrastructural adaptation to intense precipitation in Hamburg has been successful because different stakeholders are working together on a single issue. This measure is readily transferable to cities in the process of developing or updating a spatial plan as it will **allow adaptation measures to be built into policy**.

Further discussion on the costs, benefits and transferability of water storage measures can be found under the section on 'droughts and water efficiency'.

## 5.3. Conclusions

This chapter has provided recommendations for city administrations that wish to design, implement and evaluate adaptation strategies and key measures to address specific climate change challenges. As far as possible, these measures have been matched with the specific characteristics of a city.

The following table summarises the adaptation measures according to the type of city they are most easily transferred to, based on the five key success factors. Arguably, all five success factors will apply to each of the climate challenges to some extent. But based on the analysis carried out, the following table identifies the key areas where a city's time, money and attention should be focused for individual challenges.

**Table 16: Relation of key success factors to climate change challenges**

| Climate change challenge | Leadership | Stakeholders | Information and knowledge | Adaptation as learning | Tools and guidance |
|---|---|---|---|---|---|
| **Loss of biodiversity** | Commitment from city government to conserve biodiversity | | In-depth knowledge of local ecosystems | | |
| **Overarching** | Vision of a sustainable, resilient city | Engagement with stakeholders is vital | | Cross over between researchers and city governments | |
| **Urban heat island effect and heat waves** | | | | Educational programmes to inform city residents | Climate change projections |
| **Drought and water efficiency** | City government funding and strong political backing | | | Awareness-raising campaigns with community | Climate change projections and local vulnerability assessment |
| **River floods and sea level rise** | | | Technical expertise and knowledge of city's most vulnerable sites | Sharing best practice with other cities | Models of sea level rise impacts |
| **Intense precipitation** | City government funding and intersectoral working to build adaptation into existing policy | Engage businesses, utility and transport providers to assess vulnerability to precipitation | | | |

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UNECE (2009) *Draft Guidance on Water and Climate Adaptation* (Convention on the Protection and Use of Transboundary Watercourses and International Lakes, Geneva 2009)

UNDP (2004) *Adaptation Policy Frameworks for Climate Change. Developing Strategies, Policies and Measures*. Annex A. Glossary of Terms

UNISDR (United Nations International Strategy for Disaster Risk Reduction) (2009): UNISDR Terminology on Disaster Risk Reduction

West, C. and Gawith, M. (Eds.) (2005). *Measuring Progress: preparing for climate change through the UK Climate Impacts Programme*. UKCIP, Oxford

# Annex 1: Working definitions of key terms

The following list of working definitions of key terms mainly draws on the UNECE Draft Guidance on Water and Climate Adaptation (UNECE 2009) and recent climate adaptation projects (Ribeiro et al 2009, EEA 2009). It has been carefully adapted to the purpose of this study ensuring at the same time coherence with the definitions used in previous work.

- **Adaptation:** Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory, autonomous and planned adaptation (IPCC, 2007):
    - **Planned adaptation:** Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.
    - **Adaptation assessment:** The practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency and feasibility.
    - **Adaptation benefits:** The avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures.
    - **Adaptation costs:** Costs of planning, preparing for, facilitating, and implementing adaptation measures, including transition costs.
    - **Adaptive capacity** (in relation to climate change impacts): The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.
- **Baseline/reference:** The baseline (or reference) is the state against which change is measured. It might be a 'current baseline', in which case it represents observable, present-day conditions. It might also be a 'future baseline', which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines.(IPCC, 2007)
- **Capacity building:** Capacity building involves creating the information and conditions (regulatory, institutional, managerial) that are needed before adaptation actions can be undertaken (West and Gawith 2005, p.46)
- **Big City:** The terms "metropolitan area" and "big city" are closely related in this project. In contrast to "metropolitan area" (referring to the urban *area* and

its functional interlinkages with the surrounding region), we relate "big city" in this study to a threshold number of inhabitants. For the purpose of this study, we set the threshold number to 100 000 inhabitants[24]. However, no officially agreed threshold for big cities exists. Several studies and strategic papers (e.g. EEA 2008b, European Commission 2004) have considered cities with at least 100 000 inhabitants as the best suited threshold definition. As another example, the Urban Audit (an initiative of the Directorate-General for Regional Policy at the European Commission, in cooperation with EUROSTAT and the national statistical offices) defines large cities for statistical purposes as having more than 250 000 inhabitants and medium-sized cities between 50 000 and maximum 250 000 inhabitants.

– **Climate change:** Climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines 'climate change' as: 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods'. See also climate variability. (IPCC, 2007)
– **Climate variability:** Climate variability refers to variations in the mean state and other statistics (such as standard deviations, statistics of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also climate change. (IPCC, 2007)
– **Extreme weather event:** An event that is rare within its statistical reference distribution at a particular place. Extreme weather events may typically include floods and droughts. (IPCC, 2007)
– **Exposure:** The nature and degree to which a system is exposed to significant climatic variations (IPCC, 2001).
– **Hazards:** A physically defined climate event with the potential to cause harm, such as heavy rainfall, drought, flood, storm and long-term change in mean climatic variables such as temperature (UNDP, 2004).
– **Impacts** (here: climate change impacts)**:** the effects of climate change on natural and human systems. Depending on the consideration of adaptation, one can distinguish between potential impacts and residual impacts (IPCC, 2007):

[24] In rare cases we included cities with fewer inhabitants where we expected a strong added value of the case study for the project.

  - Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation. This allows for an assessment of all effects of climate change if no adaptation occurs for a specific sector or area.
  - Residual impacts: the impacts of climate change that would occur after anticipatory, planned and/or autonomous adaptation. This would allow assessing the actual need for intervention for a specific sector or area.
- **Indicators:** quantitative or qualitative parameters that provide a basis for assessing change, they are logically tied to stated policy goals and chart progress towards policy targets.
  - Adaptation indicators: A measure of progress towards the implementation of adaptation measures (process-based) or a measure of effectiveness of adaptation policies and activities in general (EEA, 2008a)
  - Vulnerability Indicators: An observable variable that provides some indication of the possible future harm a system of interest is facing
  - Index / indices: An aggregate indicator. An index combines several observable variables into one.
- **Infrastructure:** The basic equipment, utilities, productive enterprises, installations and services essential for the development, operation and growth of an organisation, city or nation. (IPCC, 2007)
- **Larger Urban Zones (LUZ):** The LUZ represents an attempt of Eurostat at a harmonised definition of the metropolitan area. The objective was to have an area from a significant share of the resident commute into the city, a concept known as the "functional urban region." To ensure a good data availability, Eurostat adjusts the LUZ boundaries to administrative boundaries that approximate the functional urban region.
- **Measure:** An action to achieve a specific objective / to respond to a specific challenge. In the context of this study, “measures” are the building blocks of a strategy. They are often directed at specific sectoral challenges (e.g. minimising the effects of heat waves, flood protection of a specific area) but may also be of a more cross-cutting nature (e.g. information campaigns to raise awareness of climate change). Measures may be taken at various levels, from the legislative to the practical. The notions of “measure” and “policy instrument” are closely linked to each other, but “measure” focuses more on the specific objective while “policy instrument” refers to the specific way of achieving it.
- **Metropolitan area:** A metropolitan area usually combines an agglomeration (the contiguous built-up area) with peripheral zones not themselves

necessarily urban in character, but closely bound to the centre by employment or commerce. In practice the parameters of metropolitan areas, in both official and unofficial usage, are not consistent. Therefore, Eurostat introduced the concept of Larger Urban Zones.

- **Mitigation:** An anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks. (IPCC, 2007)
- **"No regrets" policy:** A policy that would generate net social and/or economic benefits irrespective of whether or not anthropogenic climate change occurs. (IPCC, 2007)
- **Opportunity costs:** The cost of an economic activity forgone through the choice of another activity. (IPCC, 2007)
- **Policy:** A plan or course of action typically directed at broadly defined and long-term objectives, guided by certain basic principles and values. Policies may be formulated at various sectoral levels, from the more broad (e.g. environmental policy, social policy) to the more narrow (e.g. flood protection policy, waste management policy).
- **Policy instrument:** A tool[25] applied to make a policy operable and achieve the set objective. There are various types of standard policy instruments usually comprising fiscal instruments (tax, subsidy or grant), regulatory instruments, hortatory instruments (information campaign), or voluntary agreements.
- **Regional:** Area covered by an administrative geographic unit below national level that is responsible for the development of the adaptation strategy (e.g. province, *Länder*, large cities). (IPCC, 2007)
- **Resilience:** The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change. (IPCC, 2007)
- **Risk:** The combination of the probability of an event and its consequences (UNISDR, 2009). Risk can also be considered as the combination of an event, its likelihood, and its consequences, i.e., risk equals the probability of climate hazard multiplied by a given system's vulnerability (UNDP, 2004).
- **Scenario:** A plausible and often simplified description of how the future may develop, based on a coherent and internally consistent set of assumptions about driving forces and key relationships. Scenarios may be derived from projections, but are often based on additional information from other sources, sometimes combined with a 'narrative storyline'. (IPCC, 2007)

[25] In this study the terms "policy instrument" and "policy tool" are used synonymously.

  - **SRES:** The storylines and associated population, GDP and emissions scenarios associated with the Special Report on Emissions Scenarios (SRES) (Nakićenović et al., 2000), and the resulting climate change and sea level rise scenarios. Four families of socio-economic scenario (A1, A2, B1 and B2) represent different world futures in two distinct dimensions: a focus on economic versus environmental concerns, and global versus regional development patterns. (IPCC, 2007)

- **Strategy** (here: Adaptation Strategy)**:** A general plan of action for addressing the impacts of climate change, including climate variability and extremes. It may include a mix of policies and measures. Depending on the circumstances, the strategy can be comprehensive addressing adaptation across sectors, regions and vulnerable populations, or it can be more limited, focusing on just one or two sectors or regions (adapted from UNDP, 2004).
- **Uncertainty:** An expression of the degree to which a value (e.g., the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable.
- **Vulnerability:** Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (IPCC, 2007).

# Annex 2: Information on Tools and Guidance

*Note:* It is not within the scope of this report to provide a comprehensive body of guiding documents and other references. The following is a highly selective list aiming at providing basic information on the tools and programmes to which the report text makes specific reference.

**AMICA (Adaptation and Mitigation – an Integrated Climate Policy Approach)**

AMICA was an INTERREG IIIC project running from 2005-2007. Its main outcomes are:

- An Adaptation Tool containing a matrix of adaptation measures (by impact types and categories of measures);
- A Mitigation Tool to analyse the potential to mitigate climate change on the local level;
- An Integration Tool containing a matrix of measures serving both adaptation and mitigation.

http://www.amica-climate.net/

**ASTRA (Developing Policies and Adaptation Strategies to Climate Change in the Baltic Sea Region)**

ASTRA was an INTERREG IIIB project running from 2005-2007. The ASTRA publication "Towards Climate Change Adaptation in the Baltic Sea Region" (Hilpert et al, 2007), comprises the main findings of the ASTRA project and presents information and recommendations on how to develop adequate adaptation strategies to deal with climate change. A number of case studies are included within the report.

http://www.gsf.fi/projects/astra/07_publications.html

**BaltCICA (Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region)**

The BaltCICA project is funded by the Baltic Sea Region Programme from the European Union's European Regional Development Fund (INTERREG IVB). The aim is to design cost-effective and appropriate adaptation strategies, also building on the findings of the ASTRA project. The project will assess the costs of climate impacts as well as costs for adaptation with respect to specific impacts.

http://www.baltcica.org/

**ESPACE (European Spatial Planning: Adapting to Climate Events)**
ESPACE was an INTERREG IIIB project running from 2003-2008. The ESPACE Guidance aims to influence the philosophy and practice of spatial planning by recommending how adaptation to climate change can be incorporated, particularly in water management. The project findings place an emphasis on behaviour change and overcoming the barriers to adaptation.

http://www.espace-project.org/

## KLIMZUG

KLIMZUG (Managing Climate Change in the Regions for the Future) is a programme funded by the German Federal Ministry of Education and Research. From 2008 onwards, seven regions in Germany are supported in their development of regional adaptation strategies for a duration of five years with a total budget of 75 million Euro. The leading idea is to initiate enduring networks of scientists and practitioners, with the prominent involvement of regional and local governments as well as businesses. Strengthening the competitiveness of regions by developing innovative, economically advantageous responses to adaptation challenges also is a key objective of the programme.

http://www.klimzug.de/en/index.php

**ICLEI Local Government Climate Change Adaptation Toolkit**
ICLEI Oceania, as part of its Adaptation Initiative, has developed a set of guidelines for local government in Australia (ICLEI 2008), though the lessons are applicable to a much wider audience. The outputs focus on the Adaptation Toolkit, which helps decision-makers to adopt a risk management approach to climate impacts assessment and adaptation and to build capacity among city and other local government administrations.

http://masgc.org/climate/cop/Documents/CCPAAI.pdf

**Local Climate Impacts Profile (LCLIP)**
An LCLIP (SNIFFER, 2008) is a tool that can be used to help local authorities and organisations assess their vulnerability to extreme weather events and the impacts they entail. The process has been developed by the United Kingdom Climate Impacts Programme (UKCIP) and is being constantly refined.

An LCLIP serves to establish a baseline upon which to plan for adaptation. It is a non-scientific process that can raise awareness of the service areas at risk from extreme weather impacts. The first stage of the LCLIP process is to research past media releases to record the number of extreme weather events in recent

years. The impacts of these events can then be examined in terms of environmental damage, disruption to normal service provision and financial implications. Subsequently, this information can be verified through a series of stakeholder interviews on the impact of the event.

http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=278

**National Indicator 188 (NI 188)**

The National Indicator 188 ("Planning to adapt to climate change") is one of 198 indicators against which the performance of local governments is assessed in the United Kingdom. The aim of this indicator is to embed the management of climate risks and opportunities across all levels of services, plans and estates. Local authorities and partnerships report on the progress made against the indicator's criteria on a yearly basis. The assessment framework distinguishes five levels:

- Level 0: Baseline
- Level 1: Public commitment and prioritised risk-based assessment
- Level 2: Comprehensive risk-based assessment and prioritised action in some areas
- Level 3: Comprehensive action plan and prioritised action in all priority areas
- Level 4: Implementation, monitoring and continuous review

**UKCIP Adaptation Wizard**

The UKCIP Adaptation Wizard helps decision-makers to assess vulnerability to current climate and future climate change. It is a five-step process:

1. Getting started;
2. Assessment of vulnerability to current climate change;
3. Assessment of vulnerability to future climate;
4. Identify, select and implement adaptation actions;
5. Keeping your strategy relevant (monitoring and taking account of changing climate science and adaptation options).

http://www.ukcip.org.uk/index.php?id=147&option=com_content&task=view

# Annex 3: Questionnaires used to collect case study data

# "Policy instruments for adaptation to climate change in big European cities and metropolitan areas"

# Questionnaire for case study data gathering Phase 1: Strategy level

## 1 Descriptive Information

### 1.1 Basic data

| | |
|---|---|
| **a. City / Metropolitan area for which the adaptation strategy has been / is being developed**<br>City (if applicable):<br>[Please insert text here.]<br><br>Country:<br>[Please insert text here.]<br><br>Metropolitan area (if applicable):<br>[Please insert text here.] | |
| **b. Contact:**<br>Name:<br>[Please insert text here.]<br>Institution, department:<br>[Please insert text here.]<br>City/Town:<br>[Please insert text here.]<br>Email address:<br>[Please insert text here.]<br>Phone number:<br>[Please insert text here.]<br>Additional information:<br>[Please insert text here.] | **c. Contact 2 (if applicable):**<br>Name:<br>[Please insert text here.]<br>Institution, department:<br>[Please insert text here.]<br>City/Town:<br>[Please insert text here.]<br>Email address:<br>[Please insert text here.]<br>Phone number:<br>[Please insert text here.]<br>Additional information:<br>[Please insert text here.] |
| **d. Number of inhabitants of the *city* (if applicable) in the most recent year for which data is available**<br><br>Number of registered residents:<br><br>Please indicate year and source:<br>Year: Source: [Please insert text here.]<br><br>If the number of actual residents differs significantly from registered residents, please also provide an estimate for the number of actual residents.<br>[Please insert text here.] | **e. Number of inhabitants of the *metropolitan area* (if applicable) in the most recent year for which data is available**<br><br>Number of registered residents:<br><br>Please indicate year and source:<br>Year: Source: [Please insert text here.]<br><br>If the number of actual residents differs significantly from registered residents, please also provide an estimate for the number of actual residents.<br>[Please insert text here.] |

## 1.2 Country level information

**Does an adaptation strategy exist at the national level?**

Yes ☐ No ☐

**If yes, please indicate:**

**a. Name of the strategy:** [Please insert text here.]

**b. Year of creation of the strategy** (if finished, otherwise expected date of publication)**:** [Please insert text here.]

| **c. Stage of completion of the strategy:** | in preparation | finalised strategy document | first implementation steps taken | comprehensive implementation steps taken |
|---|---|---|---|---|
| | ☐ | ☐ | ☐ | ☐ |

Comments: [Please insert text here.]

**d. Does it mandate or encourage the creation of local or regional adaptation strategies...**

Yes ☐ No ☐

**e. ... or provide an umbrella for existing ones?**

Yes ☐ No ☐

Comments: [Please insert text here.]

## 1.3 Basic information on the city or regional adaptation strategy

| **a. Name of the strategy** | **b. Year of creation of the strategy** (if finished, otherwise expected date of publication) |
|---|---|
| [Please insert text here.] | Year: |

**c. Lead administrative body of strategy**

[Please insert text here.]

| **d. Stage of completion of the strategy:** | in preparation | finalised strategy document | first implementation steps taken | comprehensive implementation steps taken |
|---|---|---|---|---|
| | ☐ | ☐ | ☐ | ☐ |

**Comments:** [Please insert text here.]

## 1.4 Context of developing the strategy

**a. Why was the strategy initiated?**

In response to an event that has already occurred (e.g. storm, flood, heat wave) ☐

As a precaution ☐

Other reasons or motivating factors (e.g. pressure from national government or non-government related stakeholders, EU policies, examples from elsewhere, research projects) ☐

Please specify:
[Please insert text here.]

**b. Is the adaptation strategy related to sustainable development strategies at the city or regional level?**

Yes ☐ No ☐
If yes, please specify
[Please insert text here.]

**c. Is the adaptation strategy part of a combined climate change mitigation and adaptation strategy?**

Yes ☐ No ☐
If yes, please specify
[Please insert text here.]

**d. Is the adaptation strategy part of an *integrated management approach* (e.g. according to the Leipzig Charter on Sustainable European Cities, or the EU Thematic Strategy on the Urban Environment)?**

Yes ☐ No ☐
If yes, please specify
[Please insert text here.]

**e. Is the adaptation strategy part of any other strategy (spatial plan, etc.)?**

Yes ☐ No ☐
If yes, please specify
[Please insert text here.]

**Additional comments:**
[Please insert text here.]

# 2 Key adaptation challenges and measures

## 2.1 Key adaptation challenges

Please indicate the relevance of individual adaptation challenges for your city or region, as well as the extent to which these are covered by the city or regional adaptation strategy:

| | **Relevant for the region**<br><br>1=most relevant<br>2=relevant<br>3=little or no relevance | **Covered by adaptation strategy**<br><br>1=priority<br>2=included<br>3=not or only marginally covered |
|---|---|---|
| **a. Adaptation challenges arising from *direct* climate change impacts** | | |
| River floods | | |
| Sea level rise | | |
| Intense precipitation, drainage and flash flooding | | |
| Drought and water efficiency | | |
| Heat waves / urban heat islands | | |
| Wind/ Storm Damage | | |
| Other<br>[Please insert text here.] | | |
| Other<br>[Please insert text here.] | | |
| **b. Adaptation challenges arising from *indirect* climate change impacts** | | |
| Water quality | | |
| Increased health and disease problems | | |
| Biodiversity loss | | |
| Migration, differential social impacts | | |

| | | |
|---|---|---|
| Other<br>[Please insert text here.] | | |
| Other<br>[Please insert text here.] | | |

**Comments:** [Please insert text here.]

## 2.2 Sectoral coverage

**a. Does the strategy follow rather a comprehensive, cross-sectoral approach or is it sector-specific?**

Comprehensive, cross-sectoral adaptation strategy ☐

Sector-specific adaptation strategy (covering one or only few sectors) ☐

**b. Which sector(s) are/is covered by the strategy?**

- ☐ Air quality
- ☐ Health
- ☐ Social life and neighbourhood management
- ☐ Flood and coastal zone management
- ☐ Water resources management
- ☐ Soil protection and biodiversity conservation, protection of green spaces
- ☐ Waste management
- ☐ Urban and regional planning
- ☐ Building and construction
- ☐ Transport
- ☐ Energy supply and consumption
- ☐ Regional/Local economy
- ☐ Tourism and leisure activities
- ☐ Emergency planning
- ☐ Finance and insurance
- ☐ Others: [Please insert text here.]

Comment: [Please insert text here.]

## 2.3 Key measures

*Among the main objectives of this study is to compile an inventory of policy tools and to elaborate good practice recommendations for individual adaptation policy instruments and measures. Therefore we would like to identify key measures within each adaptation strategy that will be examined in more detail in a second phase of this survey.*

**a. What do you believe will be the three most important measures to attain the objectives of the adaptation strategy, and why?**

**Key measure 1**:
[Please insert text here.]

**Key measure 2**:
[Please insert text here.]

**Key measure 3**:
[Please insert text here.]

Additional comments: [Please insert text here.]

**b. Please indicate contact persons for these measures (if different from the person filling in this questionnaire)**

**Contact for key measure 1**:
[Please insert text here.]

**Contact for key measure 2**:
[Please insert text here.]

**Contact for key measure 3**:
[Please insert text here.]

## 2.4 Prioritisation

**When setting priorities on adaptation challenges, sectors and/or individual measures, which of the following factors were taken into account?**

- ☐ Perception of urgency (pressing problem, e.g. high flood vulnerability)
- ☐ Vulnerability assessment
- ☐ Available financial, personnel, and other resources
- ☐ Synergies with policy objectives other than adaptation
- ☐ Acceptance of measures / absence of conflicts and trade-offs
- ☐ Community planning process (e.g. LA 21)
- ☐ Based on stakeholder consultation
- ☐ Others: [Please insert text here.]

Comment: [Please insert text here.]

# 3 Resources and Challenges

## 3.1 Resources

**a. How long did/will it take to develop the strategy?**

<1year ☐ >1 <2 years ☐ >2 years ☐

Comments: [Please insert text here.]

**b. What resources were/will be used to *develop* the strategy? What sources of funding are / have been available? Please specify and quantify if possible.**

**Financial:** [Please insert text here.]

**Personnel:** [Please insert text here.]

**External support:** [Please insert text here.]

Comments: [Please insert text here.]

**c. What resources were/will be used to *implement* the strategy? What sources of funding are / have been available? Please specify and quantify if possible.**

**Financial:** [Please insert text here.]

**Personnel:** [Please insert text here.]

**External support:** [Please insert text here.]

Comments: [Please insert text here.]

## 3.2 Data and information used to develop strategy

**a. What climate scenarios – if any – were used to develop the strategy?**

International (e.g. IPCC SRES) ☐
Please specify [Please insert text here.]

National (e.g. UKCIP02) ☐
Please specify [Please insert text here.]

Regionally adapted ☐
Please specify [Please insert text here.]

**b. What climate models (or model data) – if any – were used?**
[Please insert text here.]

**c. What climate change vulnerability and impact/risk assessments – if any – were used?**

National ☐
Region specific ☐

Please specify [Please insert text here.]

**d. Were other city or regional adaptation strategies used to inform the design of this strategy?**
Yes ☐ No ☐

**If yes, please indicate:**

**- From which cities / regions:**
[Please insert text here.]

**- Were specific policies and measures adopted or modified?**
Yes ☐ No ☐
If yes, please mention which: [Please insert text here.]

**- Did information exchange within existing national or international networks of cities or regions play a role in transferring good practice?**
Yes ☐ No ☐
If yes, please specify network(s) and in which way they have been useful
[Please insert text here.]

## 3.3 Key challenges in developing the strategy

**What have been the most important challenges in developing the strategy, and in which way have they been addressed?**

- ☐ Lack of data
  [Please insert text here.]
- ☐ Uncertainty regarding climate predictions
  [Please insert text here.]
- ☐ The complexity of climate change, vulnerability and risk
  [Please insert text here.]
- ☐ Constraints of resources (budget, personnel)
  [Please insert text here.]
- ☐ Lack of political commitment
  [Please insert text here.]
- ☐ Lack of clarity in responsibilities and insufficient administrative structure
  [Please insert text here.]
- ☐ Lack of communication between administrative levels / departments
  [Please insert text here.]
- ☐ Other
  [Please insert text here.]

Comment: [Please insert text here.]

# 4 Involvement in strategy development and implementation

**a. Has there been a binding political commitment (such as a city council decision) regarding:**

**The process of developing the strategy** (including the allocation of financial and human resources to it): Yes ☐ No ☐

**Implementation of the strategy** (in terms of integrating its objectives and individual measures into the formal administrative governance process)**:** Yes ☐ No ☐

**An evaluation / periodic update of the strategy**: Yes ☐ No ☐

Comments: [Please insert text here.]

**b. Which administrative bodies / departments were/are involved?**

Next to the lead administrative body of the strategy did/will any other administrative bodies participate in the

...development or the strategy ☐
Please name and specify role: [Please insert text here.]

...implementation of the strategy ☐
Please name and specify role: [Please insert text here.]

**c. Which stakeholders were/are involved in strategy *development*? What was/is the degree and type of their involvement?** (e.g. partnership approach or consultative role)

Private organisations (e.g. SMEs) ☐
Please name and specify role: [Please insert text here.]

Research institutions ☐
Please name and specify role: [Please insert text here.]

NGOs and/or citizens' initiatives ☐
Please name and specify role: [Please insert text here.]

Governments of neighbouring cities / regions ☐
Please name and specify role: [Please insert text here.]

Other (please name and specify role): [Please insert text here.]

**d. Which stakeholders are involved in the *implementation and management* of the strategy?**

Private organisations (e.g. SMEs) ☐
Please name and specify role: [Please insert text here.]

Research institutions ☐
Please name and specify role: [Please insert text here.]

NGOs and/or citizens' initiatives ☐
Please name and specify role: [Please insert text here.]

Governments of neighbouring cities / regions ☐
Please name and specify role: [Please insert text here.]

Other (please name and specify role): [Please insert text here.]

**e. Have public consultation procedures been employed during the *development* of the strategy?**

Yes ☐ No ☐

If yes, what type (e.g. round tables, workshops, online questionnaires, etc.)?

[Please insert text here.]

**f. Does the strategy call for on-going public consultation during the *implementation* of strategy components?**

Yes ☐ No ☐

If yes, in which way: [Please insert text here.]

# 5 Monitoring & evaluating the implementation of the strategy

**a. Are criteria, indicators and/or targets elaborated to monitor and evaluate success of the adaptation strategy?**

Yes ☐ No ☐

**b. If yes, which ones?** (Where appropriate, make reference to official documents detailing criteria, indicators and/or targets)

**Criteria**:
[Please insert text here.]

**Indicators**:
[Please insert text here.]

**Targets**:
[Please insert text here.]

**c. Is there an evaluation exercise envisaged?**

Yes ☐ No ☐

**d. If yes, how is it designed?**

**Distinct output (e.g. report, meeting)?**
[Please insert text here.]

**Is the evaluation repeated at regular intervals (if yes in which)?**
[Please insert text here.]

**Is the evaluation output designed as basis for improvement of the strategy?**
[Please insert text here.]

**Comments:** [Please insert text here.]

# "Policy instruments for adaptation to climate change in big European cities and metropolitan areas"

# Questionnaire for case study data gathering Phase 2: Individual adaptation measures

## 1 Basic data

| | |
|---|---|
| **a. City / Metropolitan area**<br><br>City (if applicable):<br>[Please insert text here.]<br><br>Country:<br>[Please insert text here.]<br><br>Metropolitan area (if applicable):<br>[Please insert text here.] | |
| **b. Contact:**<br>Name:<br>[Please insert text here.]<br>Institution, department:<br>[Please insert text here.]<br>City/Town:<br>[Please insert text here.]<br>Email address:<br>[Please insert text here.]<br>Phone number:<br>[Please insert text here.]<br>Additional information:<br>[Please insert text here.] | **c. Contact 2 (if applicable):**<br>Name:<br>[Please insert text here.]<br>Institution, department:<br>[Please insert text here.]<br>City/Town:<br>[Please insert text here.]<br>Email address:<br>[Please insert text here.]<br>Phone number:<br>[Please insert text here.]<br>Additional information:<br>[Please insert text here.] |

# 2 Brief characterisation of the measure

| | | | | | |
|---|---|---|---|---|---|
| **a. Name of the measure**<br><br>[Please insert text here.] | | | | | |
| **b. Brief description of the measure (including sub-measures if applicable)**<br><br>[Please insert text here.] | | | | | |
| **c. Lead administrative body**<br><br>[Please insert text here.] | | | **d. Year of introduction** (if already implemented; otherwise year for which introduction is planned, if applicable)<br><br>[Please insert text here.] | | |
| **e. Cost of the measure**<br><br>[Please insert text here.] | | | **f. Sources of financing (e.g. administrative budget, external research funding)**<br><br>[Please insert text here.] | | |
| **g. Stage of implementation** | proposed / early planning stage | advanced planning stage | implemen-tation started | fully implemented | discontinued[1] |
| | ☐ | ☐ | ☐ | ☐ | ☐ |
| [1] e.g. legislative instrument no longer in place; information campaign or research project of limited duration | | | | | |
| Comments: [Please insert text here.] | | | | | |

# 3 Objectives

**a. What kind(s) of adaptation challenge(s) does the measure address?**

- ☐ River floods
- ☐ Sea level rise
- ☐ Intense precipitation, drainage and flash flooding
- ☐ Drought and water efficiency
- ☐ Heat waves / urban heat islands
- ☐ Wind/ Storm Damage
- ☐ Water quality
- ☐ Increased health and disease problems
- ☐ Biodiversity loss
- ☐ Migration, differential social impacts
- ☐ Other: [Please insert text here.]

**b. What sector(s) does the measure address?**

- ☐ Air quality
- ☐ Health
- ☐ Social life and neighbourhood management
- ☐ Flood and coastal zone management
- ☐ Water resources management
- ☐ Soil protection and biodiversity conservation, protection of green spaces
- ☐ Waste management
- ☐ Urban and regional planning
- ☐ Building and construction
- ☐ Transport
- ☐ Energy supply and consumption
- ☐ Regional/Local economy
- ☐ Tourism and leisure activities
- ☐ Emergency planning
- ☐ Finance and insurance
- ☐ Others: [Please insert text here.]

**c. What is the main adaptation objective of the measure?**

Raise awareness and improve the information base
(e.g. through studies, information campaigns, flood risk maps) ☐

Reduce risk and sensitivity (i.e. pre-emptive action to reduce the sensitivity of people, property or nature to changed climatic conditions) ☐

Coping with extreme events
(e.g. emergency planning in the case of floods or heat waves) ☐

Make use of potential beneficial effects of climate change (e.g. adaptation to more favourable conditions for tourism or agriculture) ☐

Other ☐

Comments: [Please insert text here.]

**d. What stage in the adaptation management cycle can the measure be related to?**

- ☐ Baseline review & vulnerability assessment
- ☐ Target setting
- ☐ Political commitment
- ☐ Implementation & monitoring
- ☐ Evaluation & reporting

# 4 Instruments for implementation

**Type of policy instrument(s) used for implementation**

| | |
|---|---|
| Fiscal instrument (tax, subsidy or grant) | ☐ |
| Regulatory instrument | ☐ |
| Planning instrument | ☐ |
| Voluntary agreement | ☐ |
| Informational instrument | ☐ |
| Monitoring instrument | ☐ |
| Other | ☐ |

Comments: [Please insert text here.]

# 5 Assessment of options and side effects

**a. Advantages of the measure over alternative options**

Which of the following factors were taken into account when selecting and designing the measure?

- ☐ Urgency
- ☐ Robustness to uncertainty (works under different climate scenarios)
- ☐ Flexibility of the measure (can be easily adapted to changing conditions or new research findings)
- ☐ Positive side effects
- ☐ Absence of negative side effects
- ☐ Cost-benefit ratio
- ☐ Feasibility of implementation
- ☐ Funding opportunities (e.g. as part of a research project)
- ☐ Equity and legitimacy (involvement of and acceptance by affected groups/stakeholders)
- ☐ Others: [Please insert text here.]

Comment: [Please insert text here.]

**b. Does the measure have positive effects with regard to objectives other than adaptation?**

If yes, please specify intended and, if relevant, observed effect with respect to one or more of the following categories:

Climate change mitigation ☐
[Please insert text here.]

Conservation of biological diversity ☐
[Please insert text here.]

Other environmental objectives ☐
[Please insert text here.]

Economic objectives ☐
[Please insert text here.]

Quality of life / social objectives ☐
[Please insert text here.]

Other objectives ☐
[Please insert text here.]

**c. Have potential negative side effects been assessed with regard to the following objectives?**

If yes, please specify risks and, if relevant, describe what measures have been taken in order to avoid or mitigate negative side effects:

Climate change mitigation ☐
[Please insert text here.]

Conservation of biological diversity ☐
[Please insert text here.]

Other environmental objectives ☐
[Please insert text here.]

Economic objectives ☐
[Please insert text here.]

Quality of life / social objectives (e.g. negative effects on certain population groups) ☐
[Please insert text here.]

Other objectives ☐
[Please insert text here.]

**d. Does the action in any way target or address a particular disadvantaged/minority group?**

Yes ☐ No ☐

If yes, which ones, and in which way?
[Please insert text here.]

**e. Does the action have any gender specific consideration?**

Yes ☐ No ☐

Comments: [Please insert text here.]

# 6 Involvement

**a.Who participated in the development of the measure?**

Other administrative bodies/departments than the lead administrative body ☐
Please name and specify role: [Please insert text here.]

Private organisations, business (e.g. small and medium-sized enterprises) ☐
Please name and specify role: [Please insert text here.]

Research institutions ☐
Please name and specify role: [Please insert text here.]

Non-governmental organisations and/or citizens' initiatives ☐
Please name and specify role: [Please insert text here.]

Governments of neighbouring cities / regions ☐
Please name and specify role: [Please insert text here.]

Other (please name and specify role): [Please insert text here.]

Comment (e.g. description of the planning process): [Please insert text here.]

**b.Who is intended to contribute to the implementation of the measure?**

Other administrative bodies/departments than the lead administrative body ☐
Please name and specify role: [Please insert text here.]

Private organisations, business (e.g. small and medium-sized enterprises) ☐
Please name and specify role: [Please insert text here.]

Research institutions ☐
Please name and specify role: [Please insert text here.]

Non-governmental organisations and/or citizens' initiatives ☐
Please name and specify role: [Please insert text here.]

Governments of neighbouring cities / regions ☐
Please name and specify role: [Please insert text here.]

Other (please name and specify role): [Please insert text here.]

Comment: [Please insert text here.]

# 7 Barriers to implementation

**a. Institutional barriers**

Are there any legal or institutional barriers that need to be overcome to implement the measure?

*(E.g. regarding administrative structures and responsibilities)*

Yes ☐ No ☐

If yes, please describe the problem and the way it is addressed.

[Please insert text here.]

**b. Societal barriers**

Is the measure in question facing negative public perception or opposition from specific groups?

*(E.g. structural flood protection measures opposed by environmental groups; opposition against restricting construction activities in flood-prone areas)*

Yes ☐ No ☐

If yes, please describe the conflict and the way it is addressed.

[Please insert text here.]

**c. Technological barriers**

Are there technological barriers to the implementation of the measure?

Yes ☐ No ☐

If yes, which ones? If applicable, please describe solutions found to overcome barriers.

[Please insert text here.]

**d. Other barriers**

Are there any other barriers to the implementation of the measure?

Yes ☐ No ☐

If yes, which ones? If applicable, please describe solutions found to overcome barriers.

[Please insert text here.]

# 8 Monitoring & evaluation

**a. Does/will a formal monitoring and/or evaluation of the measure take place?**

Yes ☐ No ☐

**b. If yes, in which way?**

[Please insert text here.]

**c. How is the success of the measure rated so far?**

[Please insert text here.]

**d. On the basis of practical experience, is there anything that could have been done better when planning / implementing the measure?**

[Please insert text here.]

**Comments:** [Please insert text here.]

# Annex 4: Template for the measure factsheet and applicability check table

**Name of measure:**

**Applied in:** (insert name of city)

**Lead administrative body:**

**Stage of implementation:** (proposed / early planning stage – advanced planning stage – implementation started – fully implemented – discontinued)

**Climate change challenge:** use info / key words from Questionnaire, 3a *(e.g. Urban heat islands)*

**Sector:** use info from Questionnaire, question 3b (*e.g. Water resource management)*

**Adaptation objective:** use info from Questionnaire, question 3c

**Related to management step:** Please mention, if possible, the step of a governance and management process the measure relates to (i.e. baseline review and vulnerability assessment, target setting, political commitment, implementation and monitoring, evaluation and reporting). From Questionnaire, 3d.

**Type of instrument(s) used for implementation of measure:**
use info / key words from Questionnaire, question 4

**Description:** insert short description of measure (2-4 sentences) in free text.

**Summary assessment** (max. 5 sentences)**:** This should summarise analytical findings (from information included in the table as well as overall judgement, in particular: Effectiveness; synergies – or conflicts – with other policy objectives, sectoral strategies etc.; framework conditions for decision-making; drivers for selecting and implementing the measure; obstacles to implementation and, potentially, solutions found to overcome them; in which aspects can the measure be rated as particularly successful or innovative?.)

**Conclusion regarding transferability and lessons learnt:** Please insert brief summary assessing the transferability (or exclusiveness) of the measure based

on completed applicability check table (2nd page). Refer to information for criterion 'transferability', Table: Applicability Check

**Name of measure:**

***Insert name of measure according to "Exploratory Overview of Interim Survey Results", Table 2: 'Preliminary list of key measures to be examined in Phase 2 of the survey'***
**Applied in:** ***insert name of city***

**Applicability Check:**
*Use modified table Criteria for checking adaptation instruments on applicability and efficiency.*

| **Criterion** | **Indicators/sub-criteria** | **Questions to be asked** |
|---|---|---|
| Effectiveness of adaptation Side effects | Adaptation function | • Why is this measure undertaken (function/objective)?<br>• Does the measure provide adaptation in terms of reducing impacts, reducing exposure, enhancing resilience or enhancing opportunities? |
| | Flexibility and Robustness to uncertainty | Is the measure effective under different (or changing) climate scenarios and different socio-economic scenarios? |
| | No regret | Does the measure contribute to more integrated climate adaptation management and bring benefits in terms of also alleviating already existing problems (social, environmental and/or economic)? |
| Efficiency/ costs and benefits | Win-win | E.g. does the measure<br>• positively affect the delivery of other strategies' objectives (e.g. sustainable development; spatial planning and urban development)?<br>• create synergies with mitigation (i.e. does it lead to decreased GHG emissions or enhancement of sinks)?<br>• contribute to inhabitants' quality of life?<br>• create business opportunities and |

| Criterion | Indicators/sub-criteria | Questions to be asked |
|---|---|---|
| | | employment?<br>• enhance economic and administrative efficiency?<br>• positively affect other sectors? |
| | Spill-over effects | Does the measure negatively affect other sectors or agents in terms of their adaptive capacity? E.g. maladaptation<br>• Does the measure risk negatively affecting other social, environmental or economic objectives, e.g. does it cause or exacerbate other environmental pressures? |
| | Low-regret | Are the benefits the measure will bring high relative to the costs (in particular over time?); If possible, consider also distributional effects (e.g. balance between public and private costs), as well as non-market values and adverse impacts on other policy goals |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | Who wins and who loses from adaptation?<br>Who decides about adaptation? Are decision-making procedures accepted by those affected – what is the process? – and (how) do they involve stakeholders?<br>Are there any distributional impacts of the climate change impacts or of the adaptation measures? |
| | Feasibility of implementation | What barriers are there to implementation?<br>• Financial<br>• Technical<br>• Social (number of stakeholders, diversity of values and interests, level of resistance)<br>• Institutional (conflicts between regulations, degree of cooperation, power of decision-making, necessary changes to current administrative arrangements) |

| Criterion | Indicators/sub-criteria | Questions to be asked |
|---|---|---|
| | | • Environmental: Any environmental conditions that prevent an adaptation measure from being implemented?<br>• Have there been any factors or instruments that helped / enabled the measure to be implemented? This could be formal (such as policy driver) or informal (such as organisational culture, role of senior manager etc.) |
| | Assessment of impacts and alternatives | Have potential impacts of the measure (in particular negative side effects, see above) been assessed?<br>Where any alternative measures rejected and why?<br>• Are there alternatives to the envisaged adaptation measure that would e.g. be less costly or would have fewer negative side effects? |
| | Monitoring and evaluation | Are there any monitoring and/or evaluation procedures in place for this measure? If so, how elaborated and effective are they?<br>Does monitoring and evaluation feed back to stakeholders and citizens in general? How? |
| | Transferability | How specifically is the measure related to the place and national / regional legislative context, governance structure, culture, traditions and idiosyncrasies?<br>How innovative is the measure?<br>Does it require extensive preparation or expertise?<br>Is the measure demanding specific procedures or mandates (e.g. in the administration, with stakeholders, in legislation, monetary investment)? |

# Annex 5: Descriptions and applicability check tables for individual adaptation measures

**Measure ID: A-1**
**Name of measure: Inclusion of climate adaptation concerns in urban spatial planning of Trafaria village**
**Applied in: Almada (PT)**

**Description:** Inclusion of climate adaptation concerns in spatial plans through the development of a local strategic plan for Trafaria village. Creating a map with the current land use and another map with flood risk areas. Crossing the land use map with the risk map in order to define vulnerable areas. The last step was to develop a concept for a revised urban plan including adaptation concerns such as improvement of rainfall drainage systems and reinforcement of natural barriers.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure is undertaken to reduce risk and sensitivity to floods through an urban planning that reduces exposure and enhances resilience. |
| | Flexibility and Robustness to uncertainty | The great advantage of this measure in relation to other measures is its feasibility for implementation. |
| Side-effects | No regret | It is a no regret measure as the knowledge about vulnerable areas to floods is robust to climate uncertainty. |
| | Win-win | The measure contributes to more integrated climate adaptation management with a special focus in areas with higher vulnerability to floods.<br>The measure will positively affect the delivery of other strategic objectives such as conservation of biological activity and economic objectives through reducing the environmental and economic risks from the construction in vulnerable areas. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | Spill-over effects | No expected negative spill-over effects. Rain water management will be improved and physical infrastructure near costal areas will benefit from reinforcement of natural barriers. |
| Efficiency/ costs and benefits | Low-regret | As there are no available information about costs and about the sources of financing, as well as no calculations about the expected savings resulting from this adaptation measure, it is difficult to assess the cost effectiveness of the measure. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | The measure alleviates existing social and economic problems as its focus is on the least well-off areas of Almada.<br>**Measure development:** Municipal Planning Department (Almada government agency) as coordinator; sustainable management department (Almada government agency) providing technical support and University Nova de Lisboa supporting with research.<br>**Implementation of the measure**: the Planning and Sustainable Management Departments (Almada government agencies), the University Nova de Lisboa. Together these institutions create a list of actions related to planning and include them in the urban master plan. For example: Protection and reinforcement of natural barriers and improvement of drainage systems). Private investors will be indirectly affected as they will have to comply with the urban master plan. |
| | Feasibility of implementation | The main barrier to implementation is to ensure local commitment by municipal directors and aldermen to the implementation of the measure. If environmental issues have a history in the municipality it is easier to implement |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | as it is a signal of political interest for climate protection. |
| | Assessment of impacts and alternatives | This is a general measure to include adaptation issues in spatial planning so alternatives were not studied. |
| | Monitoring and evaluation | Adaptation indicators will be included in the standard evaluation proceedings of the Urban Master Plan. The Urban plan needs to be monitored through using indicators and these indicators will definitely have a strong focus on increased adaptation and resilience. |
| | Transferability | The measure is relatively easy to introduce if there is local political commitment to environmental issues. It is also important to have local knowledge about risks and most vulnerable sites. The implementation of the measure has a cost that must be covered by the municipality and not all municipalities have financial resources available for this measure. |
| Lessons learnt | (linked to transferability) | Availability of technical knowledge, political willingness and available financial capital are together the most important aspects to take into account when developing the measure. |

**Measure ID: Bo-1**
**Name of measure: Measures to reduce erosive impacts from rainfall deluges.**
**Applied in: Bologna (IT)**

**Description:** These measures are to control the rate of storm water discharge into the river. Sub-Measure 1: Regulations requires all new building developments to include 500 $m^3$ of rainwater storage for each hectare of land in the development. The water storage volume can be underground (the usual situation) or as a surface water collection system. There needs to be water release controls to slow the rate of discharge. Sub-Measure 2: Creation of, or further development of, areas near the river where large volumes of water can be collected and held for short periods during the rainy season (July and August). This includes improvements to the banks of existing lakes near the river so that the normal water level can be raised when necessary.

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | These measures are to reduce impacts from extreme rain events. While not part of an adaptation plan, it provides effective adaptation in terms of reducing impacts. |
| | Flexibility and Robustness to uncertainty | These measures are expected to be effective under different (and changing) climate scenarios and different socio-economic scenarios. |
| Side effects | No regret | These measures do not yet contribute to a more integrated climate adaptation management. |
| | Win-win | These measures aim to reduce the damage from extreme rain events. Society wins. |
| | Spill-over effects | These measures do not negatively affect other sectors or agents in terms of their adaptive capacity. |
| Efficiency/ costs and benefits | Low-regret | The benefits from these measures are expected to be relatively high to the costs, over time. |
| Procedural aspects and framework conditions | Equity and legitimacy | Residents of the city are expected to win in the longer term. |
| | Feasibility of | Implementation of these measures required |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| for decision-making | implementation | the council to consult on the measure with affected parties. But the impacts of the severe rain events (floods) meant that the demand for the Council to "do something" was clear. |
| | Assessment of impacts and alternatives | There are no known negative side effects for these measures. There were no relevant or cost-effective alternative measures. |
| | Monitoring and evaluation | There are not yet any monitoring and/or evaluation procedures in place for these measures. An assessment is likely in the future – following the next severe flood event. |
| | Transferability | These measures are not related to the national / regional legislative context. They are relatively standard for many LGs. They require little preparation or expertise in development and consultation. They are not demanding in procedures or mandates. |
| Lessons learnt | (linked to transferability) | These measures were developed to reduce the damaging impacts of floods following extreme rain events. It was obvious that these measures would lead to cost increases for building developers but these additional costs were considered acceptable to stakeholders.<br><br>A history of damage from extreme rain events was the main driver for these measures. The appropriate implementation solution was considered to be the introduction of changes to the building regulations. |

**Measure ID: Bo-2**
**Name of measure: Water conservation measures**
**Applied in: Bologna (IT)**

**Description:**
Water conservation measures were included in the new building codes approved in 2009. There are multiple components to this measure:

- Requirement for use of water-efficient technologies and devices in new houses

- Requirement for rainwater collection systems for use in gardens and pools.
- Encouraging installation of separate piping systems for toilet flushing in preparation for installation of future grey water collection systems (but grey water collection and storage systems are not yet approved).

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | These measures are to reduce impacts from extreme drought events. While not part of an adaptation plan, they provide effective adaptation in terms of reducing drought impacts. |
| | Flexibility and Robustness to uncertainty | These measures will be effective under different (and changing) climate scenarios and different socio-economic scenarios. However, they may be insufficient to reduce the need for more water storage or further conservation measures. |
| Side effects | No regret | These measures will become a small component to a more integrated climate adaptation plan. |
| | Win-win | These measures aim to reduce the need for more water storage, and are more cost effective than new storage. Society wins. |
| | Spill-over effects | These measures do not negatively affect other sectors or agents in terms of their adaptive capacity. |
| Efficiency/ costs and benefits | Low-regret | For the city these measures are expected to have relatively high benefits relative to the costs. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | Residents of the city are expected to win in the longer term. |
| | Feasibility of implementation | Implementation of these measures required the council to consult on the measure with affected parties. But the impacts of summer droughts meant that there was a demand for the Council to “do something”. |
| | Assessment of impacts and alternatives | There are no negative side effects for the measures implemented so far. Possible negative implications from the |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | collection and storage of grey water are still being considered, and this measure has not yet been approved. |
| | Monitoring and evaluation | There are not yet any monitoring and/or evaluation procedures in place for these measures. |
| | Transferability | These measures are not related to the national / regional legislative context, and are relatively standard for many LGs. They require little preparation or expertise in development and consultation. They are copied from other local governments, and are not demanding in procedures or mandates. |
| Lessons learnt | (linked to transferability) | These measures were developed to reduce the damaging impacts of extreme drought events. It was obvious that these measures would lead to cost increases for building developers but these additional costs were considered acceptable to all stakeholders.<br><br>A history of water shortage from droughts was the main driver for these measures. The appropriate implementation solution was considered to be the introduction of changes to the building regulations. |

**Measure ID: Bo-3**
**Name of measure: Measures to improve the urban micro-climate**
**Applied in: Bologna (IT)**

**Description:** The new (2009) building regulations included a number of measures that will help improve the micro-climate in areas of the city. Two of the most significant aspects were requirements to include many plants (selected species) outside new building developments, and for these new buildings to use light colours on the roof to help reduce urban heat island impacts. The building regulations introduced the concept of a "Building Impact Index" that allows developers a lot of choice as to how they achieve the desired results.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | • Reduce risk and sensitivity<br>• This measure will help provide some adaptation protection in terms of reducing impacts from urban heat islands in the city. |
| | Flexibility and Robustness to uncertainty | This measure should remain effective under different (or changing) climate scenarios and different socio-economic scenarios. |
| Side effects | No regret | This measure does not contribute significantly to a more integrated climate adaptation programme. |
| | Win-win | This measure should be considered a small element that will help deliver a more sustainable and healthy place to live. There are a few synergies with mitigation, in that the amount of cooling needed is reduced, while still offering an improved life style with fewer GHG emissions. |
| | Spill-over effects | The measure does not negatively affect other sectors or agents in terms of their adaptive capacity, nor does it negatively affect other social, environmental or economic objectives. |
| Efficiency/ costs and benefits | Low-regret | Over time the benefits from this measure will be high relative to the costs. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | The Building Impact Index was developed based on solid science (using the local university skills) and was consulted on with architects and engineers along with the other aspects of the new building code. It was accepted as a suitable measure for implementation via the Building Code. |
| | Feasibility of implementation | This measure is clearly working in other cities, but there have been two main barriers to the implementation in Bologna:<br>• Firstly there has been objection that developers should not the only ones |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | who support the cost of this measure even though the calculations allow users a wide range of options for achieving the desired outcomes.<br>• Secondly, although this calculation method was copied from a similar measure implemented at another city (Bolzano?) complaints have been received that the Building Impact Index calculation formula is too complex to implement for some "technicians" (architects and engineers). |
| | Assessment of impacts and alternatives | The above aspects of the measure are still being assessed. |
| | Monitoring and evaluation | Monitoring and evaluation is still in progress. |
| | Transferability | The measures appear to be simple to transfer to other local governments. However, transferability needs to be reassessed when the tool is in full operation and has been evaluated. |
| Lessons learnt | (linked to transferability) | Not yet. |

**Measure ID: Bu-1**
**Name of measure: Heat Alert System**
**Applied in: Budapest (HU)**

**Description:** The HAS in the city of Budapest is integrated into the national Heat Alert System and the European one, and has three levels. The Heat Alert was declared for the first time in Budapest in July 2007. In Budapest under the Heat Alert of second and third level special action plans are developed for the organizations involved. For instance, health institutions get ready for the increased number of patients with heart ailments and women giving premature births, the ambulance service increases the number of cars on duty for one shift by approximately one third, mass media distribute information on the Heat Alert within the blocks of news and produce special broadcasts/articles on how to

protect yourself and the other people around, the municipality provides some extra communal services.

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | This measure seeks:<br>• To increase the resilience of the population towards the unfavourable outdoor conditions threatening health (heat waves, extreme events, smog);<br>• To increase the awareness of the population about the adverse health effects of the extreme events and individual measures to lessen their impact. |
| | Robustness to uncertainty | This is a no-regret key measure. Under any climate scenario, the heat alert system is worthwhile developing in any region where the heat wave problem already exists. In Budapest the spells of hot weather have been observed regularly since the year 1871 when regular meteorological observations began. |
| | Flexibility | The system can be easily modified in accordance with the existing challenges. |
| Side-effects | No regret | The measure contributes to the improvement of productivity in all sectors due to fewer sick leave days (for employees and their children) and lessens the burden on the national social security system |
| | Win-win (or win-lose)? | The measure entails side benefits for other social, environmental or economic objectives, especially when it is coupled with the traffic restrictions:<br>• Increased efficiency of public transportation;<br>• Improved air quality in the city; |
| | Spill-over effects | No spill-over effects |
| Efficiency/ costs and benefits | Low-regret | It is rather difficult to assess the avoided losses because of health problems. However, the avoided losses outweigh the costs of the activities carried out. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Framework conditions for decision-making | Equity and legitimacy | All the population groups benefit from the measure, especially vulnerable ones. |
| | Feasibility of implementation | What barriers are there to implementation?<br>• Financial (it was more like a challenge rather than a barrier)<br>• Social (psychology of denial) |
| | Monitoring and Evaluation | The dynamics of excess mortality rate. It should be negative.<br>The heat waves provoke complications with people with heart and respiratory diseases and lead to excess mortality. The measures carried out during Heat Alerts should decrease the level of excess mortality. |
| | Alternatives | None |
| | Transferability | The systems of environmental alerts (heat, UVA, and smog) are transferable at low costs. The major success factors are strong political will and stakeholders' cooperation, i.e. the willingness to develop the protocols of actions for all the organisations involved as well as the willingness of these organisations to follow the protocols. Therefore, this is mainly an institutional challenge. The activities described in the protocols can be modified in accordance with the local conditions. |

**Measure ID: Bu-2**
**Name of measure: Traffic restrictions during the Smog Alert days**
**Applied in: Budapest (HU)**

**Description:** The traffic restrictions during the Smog Alert days provided that vehicles whose license plates ended in an even number could be used only on even dates of the month and vehicles with odd numbers only on odd dates. Public transport vehicles (including taxis), police, ambulance and fire services and vehicles of the diplomatic corps are exempt from the restrictions. In Budapest the Smog Alert does not necessarily correspond with the Heat Alert However, air quality decreases during times of hot temperatures because the heat and sunlight essentially cook the air along with all the chemical compounds lingering within it. This makes breathing difficult for those who already have respiratory ailments or heart problems.

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | This measure seeks:<br>• To decrease the impact on human health of the harmful air pollutants. This impact is exacerbated by the high temperatures;<br>• To increase the resilience of the population towards the unfavourable outdoor conditions threatening health (heat waves, extreme events, smog);<br>• To decrease the additional urban heating from transport. |
| | Robustness to uncertainty | This is a no-regret key measure for the indirect impact of climate change |
| | Flexibility | The system can be easily modified in accordance with the existing challenges. |
| Side effects | No regret | The measure contributes to the improvement of productivity in all sectors due to fewer sick leave days (for employees and their children) and lessens the burden on the national social security system |
| | Win-win (or win-lose)? | The measure entails side benefits for other social, environmental or economic |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | objectives, especially when it is coupled with the traffic restrictions:<br>• Increased efficiency of public transport;<br>• Improved air quality in the city; |
| | Spill-over effects | Social tension and disapproval from public forced to commute for the long hours via public transport |
| Efficiency/ costs and benefits | Low-regret | It is rather difficult to assess the avoided losses because of health problems. However, the avoided losses outweigh the costs of carrying out the activities. |
| Framework conditions for decision-making | Equity and legitimacy | All the population groups benefit from the measure, especially vulnerable ones. |
| | Feasibility of implementation | What barriers are there to implementation?<br>• Lack of cooperation from the public<br>• Lack of enforcement from the local police force<br>• Lack of public awareness of the necessity for the measure |
| | Monitoring and Evaluation | The dynamics of excess mortality rate. It should be negative.<br>The heat waves provoke complications with the people with heart and respiratory diseases and lead for excess mortality. The measures carried out during Heat Alerts should decrease the excess mortality. |
| | Alternatives | None |
| | Transferability | The measure can be transferable at low costs. The necessary elements for successful implementation are good work by local public transport, strict enforcement of the restriction, and a public awareness campaign explaining the necessity for this measure. . |

**Measure ID: C-1**
**Name of measure: Expansion of sewer (1st stage of the measure) and set up of SUDS (SUstainable Drainage Systems): reservoirs to store rain and wastewater, green roofs, "green and blue" elements in the city (2nd stage).**
**Applied in: Copenhagen (DK)**

**Description:** The measure focuses on reducing Combined Sewer Overflows and on reusing rainwater as a resource, mainly for recreational purposes.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure is undertaken to reduce the rainwater to cause CSO (combined sewer overflows) fulfilling the objectives of the Water Framework Directive. As well as their remedial function in connection with climate change adaptation, the blue and green elements also add visual value to the city and highly contribute to the protection of soil and green spaces and to the conservation of biodiversity. |
| | Flexibility and Robustness to uncertainty | The measure aims to work under different climate scenarios and is planned to be flexible and adaptable to changing environmental conditions. |
| Side effects | No regret | The measures foster more integrated climate adaptation and have the potential to bring further environmental (e.g. conservation of green areas and fauna and flora, with related increased quality of life) and economic benefits (e.g. tourism and leisure activities). |
| | Win-win | Establishing a green structure in the city will improve access to green areas and will help to offset heat waves and absorb rainwater. Part of the green structure will also be establishing pocket parks, which are small parks which have a cooling effect on the city and where water features can be built to retain some rainwater. Green roofs, for example, are already becoming a part of the |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | municipality's base plan. They are able to absorb a large amount of the rainwater which would otherwise end up in the sewers and they also have a number of other advantages: they reduce the temperature in the city, create a better indoor climate, provide a living habitat to plants and animals as well as offering additional green recreational spaces where people can spend time in the city. |
| | Spill-over effects | It is unlikely that the measures would negatively affect other sectors or agents in terms of their adaptive capacity, or that they would exacerbate other environmental pressures. |
| Efficiency/ costs and benefits | Low-regret | It is likely that the benefits in the long term will outweigh the costs of implementation, which have so far reached EUR 140 million. The future actions in SUDS' costs are not included in this amount; they will be two or three times more than this amount and represented mainly by taxes, subsidies and grants.<br>While it will be fairly easy to estimate the direct benefits (e.g. decrease of the costs of wastewater treatment, general saving of water costs by reusing rainwater as service water, for example for flushing and cleaning purposes), it will be harder to estimate the more indirect ones (e.g. the capacity of green roofs to help cool down the temperature during summer and to act as heat insulator in winter, providing therefore energy cost savings; the protection of urban biodiversity; an increased quality of life; economic benefits deriving from an expanding tourism. |
| Procedural aspects | Feasibility of implementation | There are two major barriers.<br>- technological: the cleaning of runoff |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | from roads (highly polluted by oil, petrol, copper, rubber) requires high expertise and costs, to come up with efficient methods to treat water (e.g. constructed wetlands);<br>- legislative: these depend highly on the municipality's ability to make demands on individuals (private citizens and businesses) by regulatory instruments and, when possible, providing guidelines for voluntary implementation. |
| | Monitoring and evaluation | The monitoring and evaluation procedures are yet to be decided and confirmed (by the end of the year). The Technical and Environmental Administration foresees that the plan, characterised by several years of implementation, will go under a review procedure every 4 years. |
| | Transferability | The numerous past and ongoing experiences with SUDS in Europe demonstrate the high potential of transferability of the above mentioned measures. This does not mean, of course, that these instruments do not require an extensive preparation, expertise or a legislative and cultural context keen on adopting innovative solutions.<br>The transfer of the measures in certain areas of the world, such as Africa and South-East Asia - with a completely different environment concerning knowledge, local financial and legislative capacity, and especially rainfall patterns (e.g. more quantity on shorter periods) would certainly represent a bigger challenge. |

**Measure ID: D-1**
**Name of measure: Energy-efficient air conditioning**
**Applied in: Dresden (DE)**

**Description:** Dresden uses two possibilities of responding to the increased demand for air conditioning in an energy-efficient way: (1) favouring absorption cooling (which allows to use excess heat from energy-efficient combined heat and power generation – CHP) over compression cooling (which mainly uses electric energy). (2) using district cooling (so far, one area in the inner city).

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | Reduction of sensitivity against high summer temperatures. The measure in the first place responds to the demand for higher standards of convenience. However, an increased need for air conditioning can also be attributed to hotter summers as a result of climate change. |
| | Flexibility and Robustness to uncertainty | The measure is effective already at present summer temperatures. The demand for more convenience can be seen as a stable trend. |
| Side effects | No regret | Air conditioning is requested by private clients and financed by them to their own benefit. Public policy – and money – comes into play to ensure this demand is met in a climate-friendly way. When designing funding policies, it is necessary to ensure that the most climate-friendly technologies are supported (i.e. to take into account up-to-date technological development, innovation potentials and the full range of alternatives) and that amounts of funding are not excessive (i.e. cover incremental costs of the environmentally-friendlier variant but do not make air-conditioning cheaper). Whether a measure is “no regret” is a complex question that needs to be assessed on each specific case. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | Win-win | On balance, absorption cooling has an advantage over compression cooling since it uses excess heat from energy-efficient CHP.<br>Similarly, district cooling is (under certain conditions) more energy-efficient than local cooling.<br>Economically, the use of absorption cooling is more favourable for the utility than compression cooling because it enables to extend the use of existing CHP capacities. |
| | Spill-over effects | A negative environmental side effect of absorption cooling is that more waste heat is released into the environment (implying that more cooling water is needed to absorb this heat) due to the lower degree of efficiency in comparison to compression cooling.<br>From an economic point of view, investment cost for absorption cooling is considerably higher than for compression cooling. The absorption variant is not economically viable without targeted financial support. |
| Efficiency/ costs and benefits | Low-regret | No quantification available in terms of $CO_2$ abatement costs. In general, determination of cost-benefit relationship requires complex considerations. Where the utility provides incentives for investment in absorption cooling (cross-subsidising), this is subject to its own business decisions. Distributional considerations are more affected where it comes to subsidising private air conditioning installations by public funds (see also “No regret” criterion). |
| Procedural aspects and framework conditions for | Equity and legitimacy | Mainly determined by business decisions on the basis of its utility and by its customers. Other groups are not materially affected by the measure to a significant |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| decision-making | | extent. Distributional impacts occur where public funding is used (cf. “Low-regret” criterion). |
| | Feasibility of implementation | Barriers to implementation:<br>• Financial: Higher investment costs of absorption chillers in relation to compression chillers<br>• Technical: Absorption cooling only suited for specific applications (regular need for air conditioning); overly high return temperatures where a certain quantity of absorption chillers is integrated in the grid<br>• Social: none<br>• Institutional: none<br>• Environmental: Availability of groundwater for cooling was a limiting factor in Dresden |
| | Assessment of impacts and alternatives | Applicability of absorption cooling, economic advantages and disadvantages are assessed on a case-by-case basis for each investment decision.<br>Impacts on groundwater (absorption of waste heat from the cooling process) were assessed according to legislative norms and this limited the application of absorption cooling in the city centre. |
| | Monitoring and evaluation | No explicit monitoring and evaluation procedure but continuous evaluation with a focus on economic criteria as part of the normal business process, as well as revisions of funding criteria (relates to funding on various levels) |
| | Transferability | Applicability depends on various local factors, e.g. existence of district heating system, building structure, individual air conditioning needs |
| Lessons learnt | (linked to transferability) | There is no obvious optimal solution when aiming for energy-efficient air conditioning. All technological options |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | have their drawbacks on economic as well as environmental terms and the choice needs to be made on a case-to-case basis taking into account a lot of aspects.<br>One particular feature of the case also is the complex interaction of funding and cross-subsidising schemes, involving federal-level energy law (CHP feed-in tariffs), state-level funding for climate-friendly energy technologies (and thereby also EU funding), tariff design in the responsibility of the utility as well as decisions on revenue use made jointly by the utility and the municipal administration. |

**Measure ID: D-2**
**Name of measure: Near-natural management of rainwater**
**Applied in: Dresden (DE)**
**Description:** In case of new infrastructure development, the investor, builder etc. is required to carry out measures enabling local infiltration, retention or evaporation of rainwater for this new development area. A concept for rainwater management is drafted by the environmental agency Dresden and becomes legally binding, once it has been integrated in the (legally) binding site plan.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure aims to cope with (intense) precipitation in urban areas and to enhance the natural hydrological water balance (and provides a variety of technological solutions). As a result, flood risk and impact of floods are reduced. In addition the level of groundwater can increase (towards a more "natural" level) and water consumption can be reduced in the event that retained rainwater is used for irrigation (in private gardens) for example. |
| | Flexibility and Robustness to uncertainty | The measure is effective already at present intense precipitation events. |
| Side-effects | No regret | Yes. See responses below. |
| | Win-win | By promoting the natural hydrological balance, the measure supports the sustainable development of the urban area and thus deals with the increased surface runoff resulting from sealed soils.<br>The measure contributes to the inhabitants' quality of life as flood risk and the impact of floods of neighbouring smaller rivers are reduced.<br>The measure contributes to regional economic development as private companies carry out practical implementation. Assuming that demand for rainwater management installation increases due to continuing number of infrastructure developments and the legal requirement to implement such |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | installations, jobs are secured or even new jobs are created. |
| | Spill-over effects | No spill-over effects have been identified. |
| Efficiency/ costs and benefits | Low-regret | There are low administrative costs for the municipality. The investor/builder etc. has to cover the costs for the installation and benefits from sewage charge savings for rainwater (because rainwater is being intercepted). In the ideal case installation cost can be amortised. Costs for installation range from 1 up to 50€/$m^2$ according to the type of measure/installation. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | In general, all participants benefit from this measure, but implementation costs need to be covered by the investor. Nevertheless there is a high level of acceptance with regards to this measure on behalf of the investors. There are several discussion rounds among urban planning agency, the environmental agency and the planning office (representing the investors' interests). Further positive side effects of this measure include: reducing the surface runoff and storing water in the soil and accumulating groundwater (to guarantee a certain water quality a biological enlivened layer is established in the installation). In addition, there is a reduced sewage charge for investors; discharged sewage plants and use of intercepted rain water for private irrigation (e.g. garden, meadow etc.). The reduced flood risk and flood impact of neighbouring smaller rivers can be seen as the major distributional impact, benefiting all surrounding areas and citizens. |
| | Feasibility of implementation | Barriers to implementation:<br>• Financial: No<br>• Technical: No<br>• Social: No<br>• Institutional: lack of knowledge of necessary participation and decision- |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | making process, responsibilities; missing regulation to enforce the measure; lack of coordination among authorities at the municipality Dresden<br>• Environmental: Natural conditions (in terms of geological underground) influence permeability of soil/underground and practical implementation of the measure.<br>• Factors or instruments that helped / enabled the measure to be implemented: Development of environmental protection legislation (referring to water and soil); strong engagement of environmental agency Dresden, flood events in 1996 and 2002; availability of technologies and knowledge |
| | Assessment of impacts and alternatives | Measure has been selected due to its feasibility of implementation, which does not require high public funding (on behalf of the Municipality/City Dresden). No potential negative side effects have been assessed and no alternative measures have been rejected. |
| | Monitoring and evaluation | There is no explicit monitoring and evaluation procedure. Once the installation has been finished, an acceptance of construction through the building control department work takes place. The investor, builder etc. is responsible for the regular maintenance of the installation. |
| | Transferability | The measure has been already implemented in a high number of cities in the western part of Germany and there is still a high demand for integrating such a concept into urban planning. As there is a wide variety of installation systems (technological solutions), different geographic conditions can be addressed. Knowledge as well as business focusing on such installations are already available. The measure is innovative in the sense that it is implemented area-wide. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Lessons learnt | (linked to transferability) | Increasing number of flood events as well as the enlargement of sealed soils in urban areas were drivers for introducing a near-natural rainwater management as component of the binding site plan for new infrastructure developments. Success factors for the implementation of this measure include: i) availability of technological solutions (enabling infiltration, retention and/or evaporation of rainwater); the ii) strong personal involvement of environmental agency Dresden (giving advice on how to distribute responsibilities in the implementation process; developing guidelines for practical implementation of the measure and developing the concept for rainwater management) and iii) the establishment of respective regulation. Major argument for the introduction of this measure (in 2002) was that feasibility costs are quite low for the municipality as the investors is asked to cover costs of the installation. There is a high level of acceptance of all involved actors. |

**Measure ID: D-3**
**Name of measure: Designation of a new drinking water protection area (Wachwitz)**
**Applied in: Dresden (DE)**

**Description:** A new drinking water protection area has been designated to ensure sufficient drinking water supply for one of the three existing waterworks of Dresden. The construction of wells to exploit the area's water reserves is also envisaged but this is subject to further developments in drinking water supply and demand.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness | Adaptation | • (The adaptation function is to expand |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| of adaptation | function | sources of drinking water supply in order to overcome potential shortages due to 1) low Elbe tides that restrict the quantity of water that can be taken as bank filtrate or as "artificial groundwater" (obtained through infiltration of Elbe water into the ground), 2) interruptions of water supply from barrages due to heavy rainfalls<br>• Thereby the measure serves to enhance resilience.<br><br>***Background:*** Dresden has three waterworks for drinking water – Tolkewitz (using bank filtrate from the Elbe river), Hosterwitz (using bank filtrate and infiltrate – "artificial groundwater" obtained through infiltration of river water into the ground – from the Elbe) and Coschütz (using water from the Weißeritz river collected through two barrages). The new drinking water protection area will contribute to the Tolkewitz waterworks by a mixed supply of groundwater and bank filtrate. Once regular water extraction is established, this will ensure that the full capacity of the waterworks can be utilised even at low tides on the Elbe river. |
| | Flexibility and Robustness to uncertainty | Designating the drinking water protection area would have been done anyway as a precaution. However, the construction of wells will only be economically justified under particular conditions of both future climate and increased demand. The measure is flexible in that the designation as a water protection area does not necessarily result in the construction of wells. The cost of land acquisition (ca. 100 000 €) and groundwater monitoring (ca. 20 000 €/year) are also small in relation to investment costs for construction (ca. 2 mil. €). |
| Side effects | No regret | The designation of the drinking water protection area has some environmental co-benefits. However, side effects (positive as well as negative) are small and there is no |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | significant adaptation or sustainable development effect beyond securing drinking water supply. |
| | Win-win | • Environmental co-benefits: The measure preserves the environmental quality of the area by restricting activities that negatively affect water quality<br>• Economic co-benefits: A secure drinking water supply contributes to an environment conducive to investment<br>• Social co-benefits: Secure drinking water supply for the entire population is also a social objective |
| | Spill-over effects | • Environmental: Groundwater extraction may have negative effects. Monitoring is set up to assess the amount and location of available groundwater and restrictions are set to avoid excess exploitation<br>• Financial / economic: The restrictions on land use imposed on residents and businesses may negatively affect them economically but this is seen as serving higher-ranking public interest. Furthermore, the current use of the area (predominantly as a residential area) is such that no excessive burdens are imposed on land users in order to achieve the needed protection status. |
| Efficiency/ costs and benefits | Low-regret | The benefits of the measure, as well as its full implementation, depend on further climatic as well as socio-economic development. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | The measure does not particularly affect disadvantaged parts of the population. It benefits the population at large (potentially, all those receiving water through public supply) as well as industry. It imposes certain burdens – but not excessive ones – on the residents of the area. In cases where acquisition of land by the waterworks is needed but land owners are not willing to sell their land, the law allows for |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | expropriation (with compensation).<br>In an analogous way to major construction activities, mandatory public participation procedures are in place to ensure adequate consideration of the interests of those affected by the measure. |
| | Feasibility of implementation | Barriers to implementation:<br>• Financial / economic: The construction of wells is associated with considerable investment cost and will only be done if there proves to be a need for it (see also "Flexibility and Robustness to uncertainty").<br>• Technical: none<br>• Social: The protection status of the area restricts two types of activities: 1) water extraction for private purposes; 2) activities that negatively affect water quality (e.g. using fertilisers; polluting industries). This creates a potential for conflicts which is addressed by the mandatory public participation procedures as well as, more generally, by DREWAG's communication efforts.<br>• Legal/ Institutional: According to law, there are relatively tight time frames between securing a drinking water protection area and starting the actual use for groundwater extraction. Taking into account possible competing interests in land and water use, the right to use water resources may expire if usage is not established. The groundwater monitoring activities currently conducted on the territory, as a preparation activity, allow for extending the period between area designation and its actual use.<br>• Environmental: none |
| | Assessment of impacts and alternatives | Aside from taking no measure to expand water supply, there are two alternatives to the measure described: 1) extend the capacity of the existing water treatment plant of the |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | Hosterwitz waterworks; 2) extend the water transport capacity from the Coschütz waterworks. The main advantage of the measure over these alternatives is that it increases resilience as it offers a diversification of drinking water sources. (See also "background" under "Adaptation function" above.) |
| | Monitoring and evaluation | There is no explicit monitoring of the measure as such. However, its further implementation (i.e. construction of wells and extraction of groundwater) depends on business decisions which are informed by an assessment of changes in climate conditions and water demand. Groundwater monitoring is an integral part of the measure. |
| | Transferability | The designation of the water protection area in Wachwitz was relatively straightforward in part because no major restrictions on current land use were required. However, establishing water protection areas can also be associated with conflicts. The earlier the potential areas of water supply are identified, the easier potential conflicts can be avoided. This is because protection can be established before significant pressure for land development occurs which was not expected in the present case). The need and potential for securing additional areas for water supply obviously depend on local conditions, including climatic and topographic factors, land use patterns as well as water demand.<br>In order to ensure sustainability of water supply, it is also important to conduct effective resource monitoring and restrict the amount of water that can be extracted. |
| Lessons learnt | (linked to transferability) | |

**Measure ID: Ha-1**
**Name of measure: RISA Project (RegenInfraStrukturAnpassung): Infrastructural Adaptation for Rainwater Management**
**Applied in: Hamburg (DE)**

**Description:** RISA develops responses to avoid flooding of basements, streets and properties and water overloading through maintaining drainage and improving water protection and inland floods protection. It further seeks to integrate water management measures into planning and to adapt the institutional setting. Results will contribute to the "Rainwater structural plan".

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The main objective is to sensibilise relevant actors from administrations, ministries, authorities etc. in the area of water management in order to show the deficits as regards, for example, sanitation issues in planning process or legal changes in administration. (Corresponds to “raise awareness and improve the information base and reduce risk and sensitivity”) |
| | Flexibility and Robustness to uncertainty | Not applicable. (Measure is a steering and informative instrument that will ideally result in regulatory and planning instruments.) |
| Side-effects | No regret | Yes. See responses below. |
| | Win-win | Positive and win-win effects occur, in case the measure results in legally binding instruments (e.g. such as integration of rainwater management in urban and regional planning). Positive effects would entail conservation of biological diversity, maintained quality of life / social objectives (because more areas are being kept open) and cost-effective solutions (as for example near-natural rainwater management is a cost-effective measure compared to huge flooding constructions). |
| | Spill-over effects | No spill-over effects have been identified. |
| Efficiency/ costs and | Low-regret | It is too early to assess the cost-benefit-ratio as the measure has recently been implemented |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| benefits | | and represents most of all an opportunity for municipal joint planning, for example, in rainwater management. Assuming the measure results in legally binding instruments, cost-effective measures can be implemented (e.g. near-natural rainwater management instead of huge flooding constructions).<br><br>Currently, the City of Hamburg is financing the project (public funding), which enhances the willingness of different working groups at the ministry to cooperate. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | At this stage the City of Hamburg or respectively relevant stakeholders such as the different working groups at the ministry (that are linked to rainwater issues and cross-cutting issues) benefit from joint planning processes as rainwater management is of joint importance and requires a common understanding as well as integration of different aspects into an overall management approach. Joint meetings aim to identify links between different sectors and working groups as well as deficits in current planning/administrative processes.<br><br>Positive and win-win effects occur, in case the measure results in legally binding instruments. Main effects are the reduced surface runoff and storing of water in the soil and accumulating ground water. Moreover, there is a reduced flood risk and flood impact of neighbouring smaller rivers (that would certainly benefit all surrounding areas and citizens.)<br><br>Positive side-effects of this measure include conservation of biological diversity, improved quality of life / social objectives (because more areas are being kept open and not built) and cost savings (by promoting cost-effective measures). |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | Feasibility of implementation | Barriers to implementation:<br>• Financial: Yes<br>• Technical: Yes<br>• Social: No<br>• Institutional: Differing perceptions/ideas among working groups and administrations; lack of responsibilities (dealing with rainwater management); lack of regulations (as regards rainwater management)<br>• Environmental: No<br>• Factors or instruments that helped / enabled the measure to be implemented: strong personal engagement of HAMBURG WASSER; financing provided by the City of Hamburg |
| | Assessment of impacts and alternatives | The measures should be rather seen as an opportunity for joint planning as, for example, rainwater management is a municipal joint task. Furthermore, the measure can be described as both a technical and political project. No potential negative side effects have been assessed and no alternative measures have been rejected. |
| | Monitoring and evaluation | Monitoring must be discussed. |
| | Transferability | Rainwater management is a concern for all urban areas facing an increasing in sealing of areas and surface.<br>(Integration of rainwater management into urban planning is already taken place in a high number of cities in Germany).<br><br>As regards the City of Hamburg the measure can be seen as innovative in the sense that different stakeholder and interest groups of the environmental ministry and administration are working together on one (new) issue. |
| Lessons learnt | (linked to transferability) | Increasing soil sealing results in increased rainwater runoff/amount exceeding drainage / channel capacity. Moreover, consequences of |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | climate change might result in a changed assessment basis.<br>These factors as well as the fact that there is no responsible authority and regulations coping with rainwater management are the reasons why the RISA project has been developed and implemented.<br><br>Success factors for the implementation of this measure include: i) financing provided by the City of Hamburg and establishment of the RISA project (that highlight the fact that rainwater management is a common joint task); ii) strong personal engagement of HAMBURG WASSER; iii) integration of private sector-related issues. |

**Measure ID: He-1**
**Name of measure: Development of climate change scenarios for the Helsinki Metropolitan Area**
**Applied in: Helsinki Metropolitan Area (FI)**

**Description:**
Finnish Meteorological Institute (FMI), contracted by HSY HRESA within the BaltCICA project, has developed climate change scenarios for Helsinki Metropolitan Area. The projections were based on the IPCC scenarios and adapted using LCLIP (Local Climate Impacts Profile) method, developed by the UK Climate Impacts Programme. The scenarios will serve as a basis for the Helsinki Metropolitan Area Adaptation Strategy.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | Climate scenarios were elaborated as a part of baseline review & vulnerability assessment for the development of Helsinki Metropolitan Area Climate Adaptation Strategy. |
| | Flexibility and Robustness to | The scenarios are based only on climate change projections and do not include |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | uncertainty | different alternatives of socio-economic development of the Helsinki Metropolitan Area. |
| Side-effects | No regret | Climate scenarios development is an important step in preparing overall adaptation strategy that would ensure integrated climate adaptation management. In terms of economic benefits, better data enabled better, more cost-effective planning.<br><br>Example: Helsinki, as a coastal city, is very concerned about sea level rise. The national estimates, dating from 1999, had to be corrected, following the calculations made by the FMI. Current estimates are slightly less optimistic and therefore construction regulations on old harbour areas have to be stricter. It is cheaper to take it into account now, at the construction stage, than to refurbish the buildings at a later stage. |
| | Win-win | The information obtained has already proved useful in improving spatial planning and urban development, in particular measures concerning water management and drainage, road maintenance, public transport and public health. Through improved planning, it will contribute to inhabitants' quality of life and enhance administrative efficiency. A systematic review of other municipal strategies from adaptation perspective is to be undertaken, based on the data included in the scenarios.<br><br>The economic results are still to come (with the adaptation strategy to be adopted in 2011) but there are already some emerging business opportunities, e.g. companies developing early warning systems for emergencies, to be sold to municipalities. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | The changes introduced on the basis of scenarios support also mitigation objectives, e.g. changes in the building code promoting resilience and low emission standards. |
| | Spill-over effects | No negative effects recognised so far, the impact on other social, environmental or economic objectives can be analysed only when the adaptation measures are defined. |
| Efficiency/ costs and benefits | Low-regret | The benefits are rated as very high, compared to moderate cost of the study ("it was cheaper than we expected"). |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | It was the city administration which decided to strengthen its adaptation activities and therefore joined the BaltCICA project. However, the obligation to prepare an Adaptation Strategy for the Metropolitan Area by 2011 was decided by the Board of Helsinki Region Environmental Services Authority, with the approval of the Mitigation Strategy in 2007. At this stage, only the city and regional administration are involved but more stakeholder involvement is planned for the next steps. |
| | Feasibility of implementation | Technical barrier - problems with data collection (e.g. for rainfall statistics, the data available is the average rainfall, which does not allow for monitoring extreme weather events)<br><br>Another issue mentioned was that some of the departments of the city administration were not fully satisfied with the projections provided, expecting more certainty and detailed information (which is obviously not possible, due to availability of data and changing climate conditions). It could be |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | difficult to get their commitment if a similar exercise is to be undertaken in the near future ("come back with this issue in 20 years").<br><br>The development of scenarios was made easier thanks to both city and metropolitan area being involved in the BaltCICA project. Apart from the funding, the project contributed necessary expertise, possibility to exchange experiences with other cities and ambitious timeline. |
| | Assessment of impacts and alternatives | Not applicable in the case of scenarios, potential negative impacts can be analysed only when the adaptation measures are defined. |
| | Monitoring and evaluation | There is no formal monitoring or evaluation defined but it is understood that the scenarios will be updated, when there is more and better data available. |
| | Transferability | Nordic local governments are traditionally strong so there is no deficit of decision-making power. The case of Helsinki is exceptional in Finland because it is the only big urban area in the country and therefore national guidance is usually difficult to apply. For this reason, it is very helpful for Helsinki to exchange experiences with other European cities, e.g. Hamburg which is also a big, coastal city and participates in the BaltCICA project.<br><br>The scenarios are of course adapted to the local context but the methodology used (IPCC projections, LCLIP tool) can be applied elsewhere in Europe. The whole process took around 5-6 months, used already existing data (collected from the departments) and was fully funded from the project budget. |

| Criterion | Indicators/sub-criteria | Text |
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| | | |
| Lessons learnt | (linked to transferability) | The scenarios have been developed as part of the BaltCICA project in which both the Helsinki Metropolitan Area and the City of Helsinki take part. The scenarios will feed into Climate Adaptation Strategy for the metropolitan area, to be adopted by 2011 (following the decision taken at the time of adopting the Climate Mitigation Strategy). On the basis of the strategy, the local governments within the metropolitan area will define their own action plans and adaptation measures.<br><br>The city administration is very satisfied with the process, both in terms of cost-effectiveness (good value for money) and relevance (data already used by the administration to improve service delivery). |

**Measure ID: Lo-1**
**Name of measure: To retrofit up to 1.2m homes by 2015 to improve the water and energy efficiency of London homes**
**Applied in: London (UK)**

**Description:** Water and energy saving measures such as shower timers and different shower heads will be implemented. Assessors will also leave home owners with information on the urban heat island effect, flooding and overheating.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | • The measure aims to reduce vulnerability to drought and to improve water efficiency.<br>• It aims to reduce vulnerability to drought and to some extent flood risks. Assessors will provide advice to those people living |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | in a flood risk zone. |
| | Flexibility and Robustness to uncertainty | The measure aims to improve water efficiency and reduce vulnerability to drought. If climate and socio-economic scenarios changed, the measure would still be effective as it helps reduce energy bills, greenhouse gas emissions and promotes water savings – actions that should be taken regardless of climate change. |
| Side effects | No regret | The measure addresses the existing problems of high energy consumption and carbon footprints as well as high energy bills. |
| | Win-win | It has positive side effects on climate change mitigation (reducing energy bills and carbon footprints). It also reduces water consumption and provides personal economic savings for householders. It also addresses quality of life objectives. For example, if people are aware of how to keep cool in hot spells, this will have positive benefits. Similarly, if people are aware of a vulnerable or elderly neighbour they will be more aware of how they can help them. |
| | Spill-over effects | No negative side effects. The only minor negative side effect would be a potential increase in the use of electric fans, which could increase greenhouse gas emissions. |
| Efficiency/ costs and benefits | Low-regret | The cost of the measure is £500 million but it is hard to quantify the cost of the benefits at this early stage. As an estimate, the cost of water and energy savings in 1.2 million homes will provide significant cost benefits.<br><br>The measure will be funded by the public in the early stages and it is hoped that private investors will be drawn upon in the middle to late stages of the project.<br><br>It is unlikely that the measure will have adverse impacts on other policy goals. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | Nobody will lose from this measure.<br><br>In addition to the lead administrative bodies (Greater London Authority, London Development Agency, London Collaborative, London Boroughs and Councils, Energy Saving Trust), utilities companies were involved in the development of the measure. Once implementation of the measure is fully underway, energy and water companies will be involved.<br><br>The measure will benefit vulnerable groups the most, particularly elderly and less wealthy householders. |
| | Feasibility of implementation | At this early stage, there appear to be no institutional or technological barriers: the technology is already proven.<br><br>In terms of societal barriers, this is a positive scheme and there has been no opposition. Some people might have a limited understanding of the benefits of the scheme and might be sceptical but on the whole there has been no opposition.<br><br>There are still some unanswered questions, but these are not barriers. For instance, how easy will it be to implement the measure in rented flats? Possible obstacles include getting hold of the landlord and deciding where the scheme will be best rolled out. Other questions still to answer include is it most cost effective to spend money implementing two measures in lots of homes or ten measures in fewer homes? |
| | Assessment of impacts and alternatives | When selecting and designing the measure, the following factors were taken into consideration:<br>• Urgency<br>• Positive side effects |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | • Absence of negative side effects<br>• Cost benefit ratio<br>• Feasibility of implementation<br>• Funding opportunities<br><br>The measure has no negative side effects and was chosen as an effective way to improve water efficiency and reduce vulnerability to drought. |
| | Monitoring and evaluation | The project team will look at cost savings and water savings to get an idea of the success rate and find out how many homes have successfully been reached.<br><br>Pilot tests are ongoing and assessors are being asked what they think of the advice they are giving. This feedback will be used to evaluate the scheme.<br><br>It is too early to report on the success of the scheme so far, however simply by engaging with people and raising awareness gives an idea of how successful the measure will be. The process has worked well so far. |
| | Transferability | The measure can be applied in any social context as it provides benefits to the widespread problems of water resource efficiency in relation to increasing drought, as well as helping to reduce greenhouse gas emissions. The benefits experienced will be direct to householders thus levels of uptake should be high.<br><br>The measure can be applied within any regional legislative context or governance structure, providing the funding is available. The cost to retrofit 1.2 million homes in London is £500 million; however a smaller scheme could be rolled out in towns and villages. It will be important to consider economies of scale to ensure the cost does not |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | entirely outweigh the benefits. The technology must also be available before the measure can be transferred.<br><br>The measure is very innovative. It requires an understanding of water and energy saving technologies which is provided by the Energy Saving Trust and utilities companies. This could be a limiting factor in its roll-out.<br><br>A scheme of this magnitude also requires political backing and commitment. However there is no need for specific procedures in legislation, although this might encourage more widespread roll-out of such schemes. |
| Lessons learnt | (linked to transferability) | The measure was developed in order to raise awareness of and improve the information base on energy and water efficiency, as well as to reduce the risk and sensitivity of Londoners to increasing drought.<br><br>The measure has political backing and commitment which will ensure the success of its implementation and delivery.<br><br>Public money is being made available for the implementation of the measure and other grants may become available during later stages. It is also hoped that private investors will help fund the middle to late stages of the project. |

**Measure ID: Lo-2**
**Name of measure: London Urban Greening Programme**
**Applied in: London (UK)**

**Description:** A number of measures make up the urban greening programmes efforts to make London a greener city:

- The Mayor has set a target of increasing green cover in inner London by 5% by 2030 and an additional 5% by 2050.

- To extend the Green Grid across London. [N.B. Green Grid aims to provide a green infrastructure network for London which enhances the functionality of the existing green space network. Climate change adaptation is one of the objectives of Green Grid].
- Implement a portfolio of actions to install 100 000$m^2$ of green roofs by 2012.

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | One of the key objectives of the London Urban Greening programme is to reduce the risk and sensitivity of people, property and nature to the urban heat island effect and surface water flooding.<br><br>The measure aims to address the adaptation challenges of river floods, intense precipitation, drainage and flash flooding, heat waves and urban heat island effect, increased health and disease and biodiversity loss. |
| | Flexibility and Robustness to uncertainty | An urban greening programme has standalone benefits, so even if climate scenarios and socio-economic scenarios change, increased green space will still be effective. |
| Side effects | No regret | The measure contributes to a more integrated climate adaptation management and bring benefits in terms of also alleviating already existing problems (social, environmental and/or economic). See responses below. |
| | Win-win | The programme has numerous side benefits including conservation of biodiversity and improving air quality, which enhance quality of life at the neighbourhood level. The programme also has the potential to improve public health and some elements of the programme are designed to meet social objectives, such as reducing current areas of deficiency for access to nature. In particular, street tree planting has been |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | prioritised according to the coincidence of areas with lowest street tree density; areas of multiple deprivation; poor air and noise quality; and, areas of deficiency for access to nature.<br><br>**Climate change mitigation:** Extensive tree planting can make a small contribution to carbon sequestration; also possibility for use of trees as carbon neutral fuel source for combined heat and power etc. Green roofs can provide additional insulation, thereby reducing energy usage.<br>**Conservation of biological diversity:** Habitat creation through woodland creation; and improvement/linking of existing green space<br>**Other environmental objectives:** Increasing vegetation cover (especially trees) can help improve air quality.<br>**Economic objectives:** Increased green cover can have important economic benefits for both residents and businesses in terms of increased property value and desirability. Green roofs can increase the lifetime of a flat roof membrane, reducing the frequency at which roofs need to be replaced. Green infrastructure as a whole also acts to attenuate rainfall, reducing the total volume of water that enters sewers (and thus requiring treatment) and can reduce the adverse economic impacts of surface water flooding.<br>**Quality of life/social objectives:** The programme has the potential to improve public health and some elements of the programme are designed to meet social objectives, such as reducing current areas of deficiency for access to nature. In particular, street tree planting has been prioritised according to the coincidence of |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | areas with lowest street tree density; areas of multiple deprivation; poor air and noise quality; and, areas of deficiency for access to nature. |
| | Spill-over effects | **Conservation of biodiversity:** A climate change adaptation driven programme could have adverse impacts by encouraging creation of low grade habitat (eg secondary woodland) on existing high quality habitat (eg flower-rich grassland). Unlikely because of robust site protection policies.<br><br>**Other environmental objectives:** Increasing tree cover can increase the pressure for water resources, especially in warm summers. However, this risk is somewhat mitigated by choosing the right trees species and the right locations, with the projected impacts of climate change in mind.<br><br>**Economic objectives:** Planting of street trees has been overseen by expert bodies in order to reduce the risk of trees causing damage to buildings. |
| Efficiency/ costs and benefits | Low-regret | £4 million has been allocated to the initial 10 000 Street Trees Programme through the London Woodland Grant Scheme. However, the wider urban greening programme has not been fully costed. Much of London's Urban Greening Programme is likely to be delivered through spatial planning measures and grant funding or sponsorship to catalyse business and public involvement. Much will be delivered by the individual London Boroughs who are the primary delivery agents. Specific budgets have been secured for the Street Trees and Priority Parks initiatives, but over the longer term the |

| Criterion | Indicators/sub-criteria | Text |
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| | | objective is to demonstrate that an urban greening programme should be integral to urban regeneration because of the economic benefits of a green infrastructure that can be measured by increased productivity and sustained private sector investment.<br><br>Direct funding is provided by the GLA and associated bodies such as the London Development Agency. Other funders include the London Boroughs and central government programme funding. There are also sponsorship and commercial partnerships, grant-funding from agencies and grant-giving bodies as well as developer contributions and planning conditions.<br><br>In terms of the Street Trees and Priority Parks these initiatives required increased expenditure. In the wider context of urban greening, over the long term there are certainly cost-saving benefits (in terms of reduced health care costs through environmental improvement, energy efficiency, reduction in surface water flooding, etc) although valuing green infrastructure has proved difficult due to the largely communal and currently intangible benefits it provides. This is an area that we are trying to develop in order to raise awareness of the benefits of enhancing green infrastructure. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | Some elements of the programme are designed to meet social objectives, such as reducing current areas of deficiency for access to nature. In particular, street tree planting has been prioritised according to: areas thought to be most vulnerable to exacerbation of the urban heat island effect |

| Criterion | Indicators/sub-criteria | Text |
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| | | under extreme summer temperatures; current street tree density; areas of multiple deprivation, air and noise quality and areas of deficiency for access to nature.<br><br>**Planning and development**<br>The Greater London Authority is the lead decision maker in this measure. Since the measure implements policies in the London Plan and Climate Change Adaptation Strategy, it has been subject to an extensive consultation exercise involving statutory agencies, the business sector and the public. Small and medium enterprises are less likely to be involved in consultation exercises, however.<br><br>University College London has been involved in the development of the 'Local Urban Climate Model and its application to the Intelligent Development of Cities' (LUCID). The Greater London Authority has been sharing current best practice with Manchester City Council.<br><br>**Implementation and delivery**<br>Developers are expected to contribute to meeting the green cover target as stated in the draft London Plan. The Greater London Authority will also work with businesses to raise awareness of the social and economic benefit of increasing green cover.<br><br>The GLA is working with University College London to see how the outputs of LUCID can be used to target areas for urban greening to provide the maximum environmental benefit. We are also exploring the ability of King's College BRIDGE project to help aid greening decision-making processes through |

| Criterion | Indicators/sub-criteria | Text |
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| | | intelligent spatial planning.<br><br>NGOs: In relation to the Street Tree Programme, Groundwork London and Trees for Cities provide support for community groups to access grant funding. With regard to wider urban greening initiatives the GLA will be working with a range of NGOs and community groups dependant upon the specific nature of the initiative.<br><br>Other: The London Boroughs are the primary delivery agents of the 'urban greening programme'. The role of the GLA is to broker relationships, influence existing delivery and lever in additional funds and resources.<br><br>The budgets and staff resources of agencies such as the Forestry Commission, Environment Agency and Natural England are being aligned with the Mayor's urban greening programme to ensure delivery of national objectives through regional policy and programmes. Similarly, the wider GLA group (especially Transport for London and London Development Agency) will ensure their programmes support delivery of the urban greening programme. |
| | Feasibility of implementation | **Institutional:** There is not always exact alignment between the policies and delivery programmes of the GLA and the wider GLA group and agencies such as Environment Agency, Forestry Commission and Natural England. The tension between national and regional policy and local delivery is not a specific problem to this programme, however.<br><br>**Societal:** The GLA is waiting to hear how |

| Criterion | Indicators/sub-criteria | Text |
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| | | the programme is received through consultation on the draft London Plan. It is possible that developers may contest the greening targets.<br><br>**Technological:** There are minor technological issues to address in the urban greening programme, including the positioning of street trees and underlying infrastructure and finding flat roofs suitable for green roof installation. In terms of policy delivery, the policies and delivery programmes of the GLA are not always exactly aligned with those of agencies such as Environment Agency, Forestry Commission and Natural England. However, tension between national and regional policy and local delivery is not a specific problem to the urban greening programme. |
| | Assessment of impacts and alternatives | The following measures were taken into account when designing and implementing the measure:<br>• Robustness to uncertainty (works under different climate scenarios)<br>• Flexibility of the measure (can be easily adapted to changing conditions or new research findings)<br>• Ability to deliver: Compared to city authorities in the US or Europe, the GLA has relatively limited ability to fund initiatives directly, or to regulate. Consequently selection of measures was determined in part to align with GLAs remit to advocate and co-ordinate |
| | Monitoring and evaluation | It is very hard to monitor the benefits of a general urban greening programme – such as quantification of reduced surface water flooding. However, the targets are largely based upon modelling outputs estimating |

| Criterion | Indicators/sub-criteria | Text |
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| | | the action required to meet the desired environmental objectives such as reducing the extreme urban heat island effect. Progress monitored in terms of meeting the targets (such as street tree numbers, reaching two million additional trees).<br><br>The urban greening programme is in the early stages of development but success to date is promising as the GLA is on target to plant 10 000 street trees by the end of 2012. |
| | Transferability | The measure itself is used widely so is not hugely innovative; however the targets and scale of this urban greening programme are particularly ambitious. The programme aims to increase green cover in inner London by 5% by 2030 and an additional 5% by 2050. The target for the whole of London is to increase tree cover by 2 million trees by 2025 and to install 100,000$m^2$ of green roofs by 2012.It is also ambitious to apply an urban greening programme on a city-wide scale, as this requires collaboration with various stakeholders.<br><br>In general the measure does not require a lot of expertise, however there are technical constraints to overcome in terms of location of street trees and underlying infrastructure and finding flat roofs suitable for green roof installation etc. The measure requires a strategic, joined-up approach with communication between all stakeholders at all times. |
| Lessons learnt | (linked to transferability) | The measures are largely **political targets** established to drive London forward in terms of urban greening and the benefits that we know such a programme delivers. For example, research such as the ASSCUE project in Manchester outlines |

| Criterion | Indicators/sub-criteria | Text |
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| | | the benefits of increasing green cover in order to reduce extreme temperatures exacerbated by the urban heat island effect. The Street Tree Programme and Priority Parks were two key **manifesto commitments** for the current administration, driven by a desire to improve Londoners' environment and also meeting secondary benefits of climate change adaptation.<br><br>There are a number of measures, and a multitude of factors affect implementation. For projects that are already being implemented, such as the Street Trees Programme and Priority Parks, these projects were enabled through **funding raised by the GLA** (e.g. efficiency savings including scrapping *The Londoner* newspaper) and positive public engagement in terms of voting for the Priority Parks and **applying for grants** to plant street trees in priority areas. Both projects relied on boroughs applying for grants to implement these projects, as well as the GLA working closely with partners required to deliver the projects on the ground (such as Groundwork London, Trees for Cities, the London Development Agency, London Tree Officers Association etc).<br><br>In terms of the Street Trees and Priority Parks these initiatives required increased expenditure. In the wider context of urban greening, over the long term there are certainly cost-saving benefits (in terms of reduced health care costs through environmental improvement, energy |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | efficiency, reduction in surface water flooding, etc) although valuing green infrastructure has proved difficult due to the largely communal and currently intangible benefits it provides. This is an area that we are trying to develop in order to raise awareness of the benefits of enhancing green infrastructure.<br><br>None of the measures have been finished yet, with a 2012 completion date for Street Trees and the Priority Parks. However, both these projects have ongoing consultations with stakeholders to ensure that the projects are meeting their requirements. Furthermore, it is worth noting that both projects were manifesto commitments and so public and stakeholder support for the measures has existed since initial implementation.<br><br>In terms of the Street Trees Programmes this is largely iterative, with lessons learnt regarding both process and delivery through consultation with stakeholders such as the London Tree Officers Association and Groundwork London. As a specific example, through consultation the GLA and partners have modified the priority areas for planting trees over time as restrictions regarding planting feasibility have become clearer. |

**Measure ID: Ly-1**
**Name of measure: Develop and increase the urban tree canopy**
**Applied in: Lyon**

**Description:** Increasing tree canopy, shade cover and create an urban network of green spaces. This often consists of integrating trees and plants in public roads and spaces, works planned and financed by the Greater Lyon agglomeration.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The implementation of the measure reduces sensitivity to the effects of climate change (increased temperatures, urban heat island effect, heavy rainfall) However, the measure's initial objectives did not relate to climate adaptation (rather to the general quality of life and attractiveness of the area), this additional benefit of the measure developed in the context of increased awareness of these issues.<br>The measure reduces impacts and enhances resilience. |
| | Flexibility and Robustness to uncertainty | As additional costs of the measure are minimal it should cope well with changing socio-economic contexts. Faced with an increase of climate effects the positive side effects of the measure will even become clearer and the demand for it might increase. To some extent there is also room for adapting the measure to different climate scenarios e.g. through excess rainwater storage and through using adapted tree species. |
| Side-effects | No regret | Yes, this is one of the greatest advantages and success factors of the measure e.g. societal demand, attractiveness, innovation in water management, uptake and treatment, air purification, mitigation in terms of reduced energy consumption etc. |
| | Win-win | Recommendations have been made on how to |

| Criterion | Indicators/sub-criteria | Text |
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| | | integrate and promote this measure through its integration into the new 2014 local urban planning strategy document (PLU – Plan Local d'Urbanisme). This updated plan should broaden its focus to spaces and non-constructed areas.<br><br>Synergies with mitigation have been achieved by reducing air conditioning demand during the summer.<br>The measure improves the quality of life, enhances economic and administrative efficiency in terms of the benefits produced vs. costs of the measure, and positively affects other sectors, for example, through increased attractiveness for tourism. |
| | Spill-over effects | Negative side effects exist and should be taken into account but they are outweighed by the benefits. They include:<br>• Potential damage during storms<br>• Allergies to pollen. Even though urban trees are not always the main cause and that this negative side effect can be significantly reduced by increasing species diversity and avoiding allergenic species.<br>• Conflict with other uses of space and preferences. For example, trees could cast a shadow on solar roof panels |
| Efficiency/ costs and benefits | Low-regret | Benefits are high and diverse and costs are covered by regular public works budget. Benefits increase in time, as the trees grow. In order to guarantee efficiency of the measure some technical expertise is required. Currently the measure only applies to public spaces managed and created by the Greater Lyon Urban Community. As access to the benefits provided is free there are no negative distributional effects. The Urban Community is seeking the adherence of private actors and local communes to its second "Tree Charter". |

| Criterion | Indicators/sub-criteria | Text |
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| | | If this succeeds the benefits could also spread to more private spaces but also to other public spaces e.g. schools managed by the communes. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | One of the success factors of this measure is that it responds to other existing demands too and has synergetic effects. The method used in the implementation is one of involvement, communication and partnership with other sectors, and compromises in order to best meet various societal demands with regard to urban spaces.<br>The development of the measure 20 years ago was based on societal demand and required for its implementation the building up of expertise in private planning offices and executing services. (100% of the execution of the Communities' public works is contracted externally)<br>Various stakeholders are included in the design and implementation process of actions related to this measure:<br>• Communication with the regional and local administration levels to enhance territorial coherence of the discourse,<br>• dynamic cooperation with private executing businesses,<br>• leverage effect of the associative network that links regional research and science organisations to the needs at the level of policy design and implementation (this allows public construction sites to also serve research and innovation purposes and furthers transfer of knowledge),<br>• Involvement of local environmental associations to increase dissemination and awareness raising close to the population. |
| | Feasibility of implementation | The following barriers to implementation can be identified: |

| Criterion | Indicators/sub-criteria | Text |
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| | | • Technical: technical aspects of the execution of works (integrating trees along roads, designing and creating green spaces, taking local conditions in account, choosing site adapted tree species, pruning and maintenance) have a high impact on the efficiency of the investment over time: allowing the best conditions for the trees to grow fast and to live long. As these actions take place in the context of urban planning and roads construction this requires an interdisciplinary technical exchange.<br>• Social: communication and perception are key to the success of the measure - the various services provided by trees and green spaces in urban areas have to become clear. However, resistance is not really an issue in this case.<br>The timing of the implementation of the measure has contributed to its success. It came at a moment when it participated in responding to demand and priorities in many sectors (water management, alternative transportation, quality of life etc.). Inter-sectoral communication, and private involvement, but also research and development in the context of public works (facilitated by an associative network in the field of greening cities: Plante et Cité: centre for landscape and urban horticulture[26]) ) |
| | Assessment of impacts and alternatives | Not applicable |
| | Monitoring and evaluation | There is a yearly measuring of the evolution of the shade cover of trees in the Greater Lyon agglomeration through GIS-based calculations.<br>The draft second Tree Charter (will be |

[26] http://www.plante-et-cite.fr/

| Criterion | Indicators/sub-criteria | Text |
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| | | published in 2011) recommends the development of more qualitative assessments of the effects of the measure e.g. through an opinion poll |
| | Transferability | There is a focus on innovation and development in the case to case implementation of the measure. The Greater Lyon Community tries to include research activities in the execution of public works e.g. analysing optimisation of water storage and uptake techniques and evapotranspiration processes. Techniques used in other sectors e.g. orchard water management are transposed to the urban context. The innovation also lies in the interdisciplinary reflection on urban green spaces and their functions.<br>The measure requires innovative thinking and a dynamic development of case to case technical and interdisciplinary solutions to respond to demand.<br>The measure is quite cost-effective and does not require extraordinary investment. An intermediate structure or organisation that can link public, private and research actors in this field can certainly contribute to the success of the measure. |
| Lessons learnt | (linked to transferability) | Implementation was enabled by:<br>- Existing measures (before climate adaptation objectives were linked to it)<br>- Good timing: responds to needs in various sectors of urban planning and services.<br>- Communication and involvement of various sectors, of private actors and of other levels of administration<br>- Research and development partnerships during the execution of works – presence of an intermediate structure<br>- Technical and interdisciplinary know-how has been dynamically developed<br>The mandatory aspects to consider the |

| Criterion | Indicators/sub-criteria | Text |
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| | | measure are:<br>- Technical quality of the execution<br>- Integration of innovative aspects<br>- Interdisciplinary approach |

**Measure ID: M-1**
**Name of measure: Adaptation Strategies for Climate Change in the Urban Environment (ASSCUE) and Green Roofs**
**Applied in: Manchester (UK)**

**Description:** ASCCUE (2003-2006) was funded by the Engineering and Physical Sciences Research Council. It aimed to assess climate change impacts and develop and test appropriate adaptation responses through spatial planning and urban design. The primary interest of the project is in the adaptation potential of green infrastructure, thus we also explore Manchester's Green Roofs project.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | Green roofs is a practical measure implemented by Manchester City Council which puts into practice the theory of ASCCUE.<br>Green roofs aim to reduce exposure to the impacts of river floods, urban heat island effect and wind and storm damage. |
| | Flexibility and Robustness to uncertainty | Green roofs and green infrastructure in general do not depend on a certain climate or socio-economic scenario. Green infrastructure has benefits which are wider than adapting to climate change (see 'win-win'). |
| Side-effects | No regret | Green infrastructure has far reaching benefits. It can improve access for inner city communities to green space, promoting a healthier, more active lifestyle. It also provides shade for both humans and wildlife; refuge during long, hot summers. However, a greener infrastructure will have a higher water demand which could be conflicting. On the |

| Criterion | Indicators/sub-criteria | Text |
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| | | contrary, green roofs reduce the need for cooling and heating as it provides natural insulation. This will reduce energy demand and thus provide cost savings. |
| | Win-win | Manchester City Council seeks to raise awareness of the benefits of Green Roofs including reduced storm water run off, reduced air pollution and dust, a reduction in the urban heat island effect, increased wildlife habitats, improved health and attractive open spaces, protection of the buildings roof from damage and reduced heating and cooling costs.<br><br>Green space also creates synergies with climate change mitigation because trees and parks act as carbon sinks. It also reduces surface water run- off but in order to cope with the extra precipitation from extreme rainfall events should be combined with additional storage such as attenuation ponds. |
| | Spill-over effects | Growing pressure for development and increasing urbanisation could lead to more frequent building on floodplains or green belts, which could compromise adaptation responses. Building on green belts could have implications for biodiversity and landscape whilst building on flood plains will lead to higher risk of damage to property, people and possessions. |
| Efficiency/ costs and benefits | Low-regret | Green roofs will have positive impacts on other policy goals including the reduction of greenhouse gas emissions by providing cooling and insulation thus reducing heating and cooling demand.<br><br>Additionally green roofs may reduce pressure on sewage systems as they are likely to form an important part of sustainable urban drainage systems which will reduce surface water run off. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | The use of green roofs is beneficial for people and biodiversity in urban environments; however property developers might be less willing to pay to incorporate green roofs as they will increase costs.<br><br>A green roof programme for Manchester is expected to play a significant role in contributing towards achieving NI 188 and Local Area Agreement commitments for reducing greenhouse gas emissions. The decision to implement green roofs has therefore been driven by local, regional and national policy.<br><br>The ASCCUE Steering Group also influences the adaptation decisions taken in Manchester. This group was made up of government departments, professional bodies and researchers who produced a communication strategy which encouraged strong stakeholder involvement and active dissemination of knowledge.<br><br>There is a strong link between vulnerability and exposure. Communities with limited adaptive capacity (the poorer, elderly, and the young) often feel the worst of climate change impacts and extreme weather events. One of the Green Roofs projects worked with SureStart, a children's day care centre, to install a green roof on one of its buildings and using this as a training event to enable other, similarly built, SureStart centres to do the same. |
| | Feasibility of implementation | Manchester City Council suggest that mainstreaming adaptation work is made more difficult by the title of the indicator 'National Indicator 188 – Adapting to Climate Change'. They suggest that climate change can put people off and they recommend relating it to |

| Criterion | Indicators/sub-criteria | Text |
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| | | 'continued service provision under a changing environment'.<br><br>Engaging service managers has proved more difficult than expected due to time constraints, work loads and unfamiliarity of adaptation to their work.<br><br>The scoping of adaptation work was made more difficult as it is a huge agenda, and to be able to produce practical results it is important to have a defined goal. This reinforces the need to incorporate adaptation into all services so that it becomes a mainstream concept rather than being seen as something that is only relevant for certain people.<br><br>Having senior political backing has proved crucial in the success of Manchester's Green Roofs project and its overall adaptation work. Manchester City Council's Chief Executive was Chair of the Environmental Strategy Programme Board. |
| | Assessment of impacts and alternatives | Green roofs are a proven measure and there are very few negative impacts. The cost benefits have been assessed by Deloitte[27]. |
| | Monitoring and evaluation | Not at present. |
| | Transferability | The ASCCUE framework could be applied to any city in Europe, but the findings are directly applicable to Manchester and Lewes, East Sussex.<br><br>Green roofs are a proven measure and are used in cities across the world. The ASCCUE research is very innovative. A common risk management framework is used and is based on hazard, exposure and vulnerability. This approach allows adaptation strategies to be |

[27] http://www.djdeloitte.co.uk/img.aspx?docid=34058&fldname=AttachmentFile&n=0&langid=1&log=1

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | developed depending upon whether one wants to reduce risk by reducing exposure or reducing vulnerability. The risk assessment carried out at conurbation scale (Manchester and Lewes, East Sussex) was effective in terms of scoping out climate change impacts and highlighting areas for closer study.<br><br>The success of the measure is based on the relationship between Manchester City Council and University. |
| Lessons learnt | (linked to transferability) | The personal interest in the adaptation agenda at Manchester City Council and Manchester University has instigated much of the work on adaptation, including Green Roofs. The City Council note that consultants at the University of Manchester had gone "above and beyond the call of duty." This was reinforced by the close working relationship between the academic community and City Council in Manchester.<br>The research was also informed by other Building Knowledge for a Changing Climate projects:<br>• Built Environment: Weather Scenarios for Investigation of Impacts and Extremes<br>• Adaptable Urban Drainage - Addressing Change in Intensity, Occurrence and Uncertainty of Stormwater<br><br>Factors enabling the measure to be implemented:<br>Partnership working between the University and the City Council, and between the Council and the local children's centre SureStart.<br><br>ASCCUE has had interest from international and national policy makers and researchers. ASCCUE has assisted the Environment Agency in their response to the North West |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | Regional Spatial Strategy and the City Region Spatial Strategy is useful for testing the ASCCUE adaptation methodology. |

**Measure ID: M-2**
**Name of measure: EcoCities**
**Applied in: Manchester (UK)**

**Description:** EcoCities[28] is being led by the University of Manchester. It draws on the expertise of the University's Manchester Architecture Research Centre, the Centre for Urban Regional Ecology and the Brooks World Poverty Institute. The project looks at how urban areas respond to climate change impacts and specifically how Manchester can adapt to the threats and opportunities presented by climate change.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | EcoCities is intended to raise awareness of climate change impacts and support adaptation in Manchester by improving the information base. It will provide guidance for stakeholders to develop adaptation strategies. The blueprint will recommend measures to reduce impacts, exposure, enhance resilience and opportunities. |
| | Flexibility and Robustness to uncertainty | EcoCities provides a conceptual framework which is effective under different or changing climate and socio-economic scenarios. |
| Side-effects | No regret | The guidance focuses on mapping climate change impacts and vulnerability to those impacts in Greater Manchester. It provides a framework which has the potential to assist the development of a joined-up, strategic approach to adaptation. |
| | Win-win | EcoCities aims to highlight locations and sectors within Greater Manchester where |

28 www.manchester.ac.uk/ecocities

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | adaptation responses would be most useful.<br><br>If the blueprint is used by stakeholders to influence strategy development, there is the potential for adaptation actions to have positive side effects in terms of issues such as climate change mitigation, conservation of biodiversity, maintaining economic competitiveness and enhancing quality of life objectives. |
| | Spill-over effects | EcoCities will not recommend any adaptation measures that conflict with climate change mitigation objectives. There is always a risk of negative impacts and the spill-over effects will depend on the way in which adaptation actions are implemented.<br><br>To help address these risks, methods such as Environmental Impact Assessment and Strategic Environmental Assessment should be carried out on projects, policies and plans relating to adaptation. |
| Efficiency/ costs and benefits | Low-regret | Whilst the cost of the measure is unknown, it is hoped that the benefits will be far reaching as the blueprint will provide guidance for stakeholders to consult when developing their adaptation strategies.<br><br>The benefits of this approach include helping to minimise maladaptation, avoiding adverse impacts on other policy goals and saving time and money in the building design process. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | Organisations including local authorities and utilities companies should lead in the development of adaptation strategies, and the University is providing assistance through its research interest.<br><br>EcoCities is mapping social vulnerability to climate change impacts to show which |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | communities are most at risk from heat stress and flooding. It tends to be the young, elderly and deprived who are disproportionately impacted by climate change. To this end EcoCities has an equity dimension, and endeavours to direct adaptation actions where they are most urgently needed in respect of vulnerability to climate change impacts. |
| | Feasibility of implementation | Commitment to the adaptation agenda and public willingness to change behaviour are potential political and business barriers. Stakeholders must regard the impacts of climate change as relevant to their daily lives otherwise they will not engage with the outcomes produced by EcoCities.<br><br>Access to knowledge and skills relating to adaptation is another barrier to the use of EcoCities outputs. Organisations must have the capacity and understanding to develop adaptation strategies.<br><br>Also, developing an adaptation strategy requires having capital to invest. A lack of capital could hinder the development of adaptation strategies using the EcoCities blueprint. |
| | Assessment of impacts and alternatives | This is not applicable as the project is not tasked with delivering adaptation responses, but is guiding their development. |
| | Monitoring and evaluation | It is hard to say what kind of monitoring procedures will be in place at this stage. It will depend on issues such as whether additional funding is available to take forward the blueprint in practice.<br><br>We can however gauge the success of the measure based on the extent to which people are engaging and showing an increased awareness of adaptation. In this respect, there is an increased awareness but this could be |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | due to other factors such as a growing political agenda for adaptation. |
| | Transferability | The EcoCities project maps climate change impacts and considers vulnerability to those impacts in Greater Manchester. However the conceptual framework underpinning the project is transferable to any city in Europe. |
| Lessons learnt | (linked to transferability) | The University of Manchester has a close working relationship with Manchester City Council which provides a useful crossover between academic research and policy. Much of the work carried out by the University has direct benefits for the City Council and other local authorities in Greater Manchester. Good communication is essential to ensure this knowledge is effectively transferred.<br><br>The Adaptation Strategies to Climate Change in Urban Environments project (ASCCUE) ran between 2002-2005/06. This project is now fully completed and acted as a genesis for further adaptation research in the city.<br><br>The significant input to adaptation from the University of Manchester has been bolstered by emerging legislation and guidance from the UK Government on adaptation. The University is well advanced in this agenda having had a keen interest in adaptation for 10 years.<br><br>The research conducted at the University intends to raise awareness and assist the development of adaptation processes. However, the City Council and other relevant stakeholders will ultimately be responsible for implementing adaptation actions.<br><br>The EcoCities project is a rare and innovative approach to advancing adaptation to climate change, and demonstrates the value of |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | research institutions contributing to this agenda. EcoCities is mapping projected climate change impacts in Greater Manchester using the UKCP09 climate change scenarios. The project is learning about patterns of past weather events in the city using the Local Climate Impacts Profile (LCLIP) method. The climate scenarios are applicable only in the UK, but the LCLIP method can be used to raise awareness of past weather events in any town, city or region in Europe. |

**Measure ID: P-1**
**Name of measure: Movable barriers as a flood protection instrument**
**Applied in: Prague (CZ)**

**Description:** The city centre of Prague, the capital of the Czech Republic, is exposed to floods threat. Both the city centre and the suburbs should be protected. While a system of fixed barriers such as dykes and dams can be used at the outskirts of the city, the historical panorama of the city centre should be preserved intact. It is one of the sites on the UNESCO World Heritage List. The solution was to utilise the temporary movable barriers at the time of floods. The movable barriers are the 3 metre-high aluminum constructions which can be erected within 12 hours along 7.8 kms of the Vltava River in the historic city centre.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure seeks:<br>• To safeguard the city of Prague from flood damage (destroyed buildings and infrastructure objects, threats to public health because of flood water access into the sewage system)**;**<br>• To preserve the cultural inheritance of Prague's historic city centre. |
| | Robustness to uncertainty | At the moment the flood defence system is created to resist the level of the millennium flood (river Vltava flow at |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | 5000 $m^3$/second) plus some safety margin. However, if the floods become more severe this system might be insufficient. Though this scenario is unlikely. |
| | Flexibility | More elements can be added to the existing flood defence system |
| Side-effects | No regret | The measure contributes to more sustainable management of tourism, a vital sector for the economy of Prague. |
| | Win-win (or win-lose)? | • The dams of the Vltava cascade not only retain flood water but also participate in hydroelectricity generation and are used for recreational purposes;<br>• Prevent from flood water from getting into the sewage system, and thus, eliminate an important threat to health, |
| | Spill-over effects | Biodiversity loss |
| Efficiency/ costs and benefits | Low-regret | The avoided losses due to the flood damages clearly outweigh the costs of construction and maintenance. |
| Framework conditions for decision-making | Equity and legitimacy | The decision to put in operation the elements of the flood defence system is taken by the Municipality of Prague in accordance with the flood defense plan upon the information from the Vltava River Authority |
| | Feasibility of implementation | What barriers are there to implementation?<br>• Financial (it was more like a challenge rather than a barrier)<br>• Technical (the same)<br>• Social (for instance, environmental action groups have been opposing the construction of the last elements of the system) |
| | Monitoring and Evaluation | Time required to install the removable barriers along the city banks upon the |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | declaration of the flood alert |
| | Alternatives | The system of flexible barriers in the city centre is the best to pursue both goals of the measure. |
| | Transferability | The designing of the flood defence system requires extensive preparation and expertise. The elements, especially constructions of the system, should take into consideration a huge number of factors specific for every city. However, such elements as flood warning, contingency flood plan and removable barriers are much easier to replicate. The movable barriers can be a solution in a number of cities whose centres representing high cultural values are under threat from floods.<br>The measure is not really innovative. The idea of the removable barriers has itself been transferred from the city of Cologne, Germany. |

**Measure ID: R-1**
**Name of the measure: Protection zones/Spatial Plan of Riga for 2006-2018**
**Applied in: Riga (LV)**

**Description:** The Spatial Plan of Riga for 2006-2010 foresees the system of protection against natural disasters associated with climate change, i.e. the system of "protection zones" (hereinafter PZ). For the purposes of the study the authors consider only the PZ along the surface water bodies within Riga and the coastal line of Riga Bay.[29]

The width of the protection zone for the bodies of surface water in Riga should be not less than 10 metres on each bank measured from the higher steep slope of shoreline. However, if there is typical periodically flooded land, then the PZ should be not less than in all width of flood-land (excluding the cases when the buildings already exist or if the bank is established by the continuous dam). The PZ of the Jugla Lake, Ķīšezers, peninsulas and islands should be not less than 20

[29] The PZ also exist around the historic buildings and the areas of high cultural value.

metres in width, and the one on the right side of bank of the Daugava from Rumbula to the border of Riga - even 30 metres.

The Riga Bay sea and mouth of River Daugava coasts are covered by the zoning of the coastal protection shelter belt that extends to a minimum of 150 m inland up to and including areas in the flood plain and beach and dune areas. (Riga Freeport is exempted from this regulation.)

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure seeks to safeguard the city of Riga property and infrastructural objects against a number of extreme events (storm surges, coastal floods, river floods) and processes (coastal erosion). Nevertheless, it is not an adaptation objective per se and it does not deal with the increased future risks of these events due to the climate change. |
| | Robustness to uncertainty | It is not robust to uncertainty |
| | Flexibility | Whether the Spatial Plan can be revised during the period of 2006-2018 – to be investigated |
| Side-effects | No regret | The Spatial Plan deals with the current risks and provide for their mitigation |
| | Win-win (or win-lose)? | N/A |
| | Spill-over effects | Construction in the potentially flooded plains can lead to the significant losses of property and infrastructure, not to mention casualties |
| Efficiency/ costs and benefits | Low-regret | To be investigated further |
| Framework conditions for decision-making | Equity and legitimacy | Stakeholder consultations have been carried out. However, environmental and science groups do not have yet voices strong enough to be heard. |
| | Feasibility of implementation | No particular barriers though some illegal construction still occurs |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | Monitoring and Evaluation | In the process of receiving the construction permit |
| | Alternatives | Spatial Plan with embedded future climate risks and adaptation considerations |
| | Lessons learnt | Interaction between scientific developments and policy making should be strengthened. For instance, within a number of national and international research projects (ASTRA, BaltCICA) the assessment of impact of the consequences of climate change has been done and the impacts (for instance, sea level rise) have been modelled. Integration of these assessments in the spatial planning process can be beneficial and mitigate the future climate risks. |

**Measure ID: R-2**
**Name of the measure: Dunes maintenance along the Riga Bay coastal line**
**Applied in: Riga (LV)**

**Description:** the main concept is "hold the line" though the measures are rather soft. They consist of renourishment of the front dunes with, preferably natural material (for instance, sandy material that is dredged from the Lielupe River) and pine tree plantations.

To protect the port facilities of Riga a 600-metre concrete revetment and a storm surge barrier were built in the 1960s and were reconstructed in 1999.

Among the "indirect measures" there is a nationwide project undertaken in 2007-2008 by METRUM Ltd entitled 'Coastline erosion and coastal area contraction and monitoring'. The aim has been to examine recent changes in Latvia's coastline. New maps of Latvia were produced. Currently, METRUM Ltd is conducting an erosion assessment for the next 10 years along with the identification of risk areas in which construction has to be restricted. Both projects are financed through the Latvian Environmental Protection Fund.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure seeks: to slow down the loss of coastal zone territories and to protect property and sites of historical value |
| | Robustness to uncertainty | Medium |
| | Flexibility | The measure can keep up with the pace of coastal erosion at the moment. However, it is not clear whether it will be sufficient if the erosion intensifies due to climate change. |
| Side effects | No regret | It is a no regret option |
| | Win-win (or win-lose)? | It is a win-win option: cleaning of the bed of Lielupe River. Also, the historical sites on the coast attract tourists. |
| | Spill-over effects | No spill over effect |
| Efficiency/ costs and benefits | Low-regret | The measures have cost about EUR 0.6 ml per year. This does not include the costs of coast monitoring. |
| Framework conditions for decision-making | Equity and legitimacy | The population living on the coast welcomes the measure. |
| | Feasibility of implementation | Mainly, financial barrier. |
| | Monitoring and Evaluation | Performed by the company METRUM Ltd. |
| | Alternatives | To develop a proper system of the Integrated Coastal Zone Management |
| | Lessons learnt | The measures are “traditional”, well known to all the coastal population for centuries, and can be easily transferred where the geo- morphological structure of the coasts allow for renourishment and pine plantation. Though an awareness-raising campaign should be conducted among the constructors to warn that the erosion might be intensified due to the climate change. |

**Measure ID: S-1**
**Name of measure: Development of the residential and commercial urban area "Stockholm Royal Seaport"**
**Applied in: Stockholm (SE)**

**Description:** A new residential and commercial urban area is being developed in a 236 ha brownfield site, and will incorporate energy efficiency and adaptation measures. It will create 10 000 new houses and 30 000 work spaces.

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The project combines a large number of sectors and addresses various challenges (eg. considering expected increased future precipitation and flooding, green architecture and green spaces to combat urban heat island effect, biodiversity habitat areas, district heating system, etc.) offering a holistic solution concept to adaptation and sustainability in general.<br>The measure provides adaptation in terms of reducing impacts, reducing exposure and enhancing resilience. |
| | Flexibility and Robustness to uncertainty | The measure's success is unaffected by different climate scenarios. Changes in the socio-economic situation may affect the real-estate market prices. |
| Side effects | No regret | The measure expects to contribute to a more integrated management of local authority operations in general, and likewise to positively affect existing social, environmental and economic problems.<br>As an example, the soil of the area has been contaminated by industrial activity and is being remediated as a result of this development. |
| | Win-win | The measure:<br>• positively affects the delivery of other strategies' objectives (e.g. sustainable development; spatial planning and urban development) by serving as a 'showroom' and a 'testing lab' for new solutions. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | • creates synergies with mitigation, e.g. by leading to decreased GHG emissions.<br>• contributes to inhabitants' quality of life by making available areas where families may lead sustainable lives.<br>• creates business opportunities and employment by attracting new residents to the area. |
| | Spill-over effects | There is no expected major negative effect resulting from this measure. Noise and traffic in the area may increase as a result of new residents, but at the same time industrial activity will be withdrawn. On the other hand, while alternative plans for the large-scale industrial activity (gasworks) has been elaborated, smaller-scale companies may suffer as a result of their displacement. |
| Efficiency/ costs and benefits | Low-regret | The benefits the measure will bring are expected to be high relative to the costs, particularly in the long run.<br>The payback time for the investment of the city is expected to be reasonably short, as the area gains attractiveness (the city owns most of this land). |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | Citizens and other stakeholders (e.g. builders and contractors) have been active players in the development of the project. Stockholm's long tradition with Agenda 21 processes has made the process of involving citizens flow easily. Builders and contractors are integrated into the decision-making process. This helps to create a sense of ownership at several levels, benefiting the final result of the project. |
| | Feasibility of implementation | What barriers are there to implementation?<br>• Institutional: Some conflicts between regulations have been identified—namely the difficulty in implementing a 'smart grid' system at the project or city level—and more integration between service providers (e.g. public transport) needs to |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | be achieved. |
| | Assessment of impacts and alternatives | Increased noise from higher population density, and blocking of view of some existing buildings are the main negative potential impacts together with the cost to industrial activities to move from the site. It is estimated, however, that benefits will widely outweigh the costs in the mid- and long-run. |
| | Monitoring and evaluation | The project developers are working with the Royal Institute of Technology of Stockholm (KTH) to determine what indicators are relevant and should be monitored regularly during the development of the project and after its completion. |
| | Transferability | The success of the measure is certainly not dependent on geographical conditions. Institutional contexts and the willingness of authorities at different national levels to work with other levels of government have a strong potential for making project implementation more or less feasible.<br>An important factor for success is that stakeholders believe and relate to the sustainable philosophy of the project and are willing to integrate their lifestyles into the neighbourhood concept. For this reason stakeholder buy-in from the start is crucial. |
| Lessons learnt | (linked to transferability) | Political support and commitment on a long-term basis must be gained from the city authorities, as the project will require high investment throughout a long construction phase (estimated 15 years for this project).<br>This project is expected to serve as a showroom to guide other similar projects within the city and beyond.<br>Creating markets and adequate market conditions can help enhance the sustainable spirit—and success—of the project. Example: Setting up a ‘smart grid’ that allows citizens to invest in renewable energy (RE) and make economic profits. |

**Measure ID: T-1**
**Name of measure: Building capacity of the fire brigade**
**Applied in: Tatabánya (HU)**

**Description:** The number of incidents of wildfires (uncontrolled fires) in forests and other vegetation (wildland fires) in Hungary has increased over the past decade. Although as the statistics show the situation around the city of Tatabánya is much better. As long as the increased amount of wild fires is associated with the heat waves the frequency of which is also growing, a protocol of action for the fire brigade has been established and training courses take place. It can be regarded as a preventative and capacity-building measure.

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure seeks:<br>• to prevent the damage from the wild fires and biodiversity loss;<br>• to prevent casualties among the firefighters due to the lack of training and capacity. |
| | Robustness to uncertainty | Regardless of the extent of the growing severity and frequency of wild fires, the existing protocol of actions is useful. |
| | Flexibility | The programme and its content can be easily modified in accordance with the existing challenges. |
| Side effects | No regret | This is a no-regret option |
| | Win-win (or win-lose)? | The measure contributes to the avoided losses in all sectors including forestry and land use due to the wild fires |
| | Spill-over effects | This is a no-regret option |
| Efficiency/ costs and benefits | Low-regret | The Municipality believes the benefits will clearly outweigh the costs. Since prevention is by definition is less costly than cure. |
| Framework conditions for decision-making | Equity and legitimacy | This measure is a part of the Local Climate Change Action Plan of Tatabánya. |
| | Feasibility of implementation | Highly Feasible. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | Alternatives | None |
| | Monitoring and evaluation | The number of training courses carried out and the number of people participating in the trainings. |
| | Transferability | The experience can be easily transferred to the municipalities with forests and other vegetation sites on its territories or close to them. |

**Measure ID: T-2**
**Name of measure: The Local Heat Alert System (HAS) of Tatabánya**
**Applied in: Tatabánya (HU)**

**Description:** The city of Tatabanya has created its own system of 3-level public HAS.
When the Mayor declares alert, faxes are sent to the local media as well as 22 organisations each having its own protocol of action. The population is notified through the local media messages and flyers that provide information on efficient measures to combat heat.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure seeks:<br>a) To reduce the number of people exposed to the harmful effects of high temperature conditions;<br>b) To increase public awareness about the heat waves impact on health and on measures efficient for self-defence against unfavourably high temperatures. |
| | Robustness to uncertainty | This is a no-regret key measure. Under any climate scenario, the heat alert system is worthwhile developing in any region where the heat wave problem already exists. In the Komarom-Esztergom Region the spells of hot weather have been observed regularly since |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | the year 1871 when regular meteorological observations began. |
| | Flexibility | The system can be easily modified in accordance with the existing challenges. |
| Side-effects | No regret | The measure contributes to the improvement of productivity in all sectors due to fewer sick leave days (for employees and their children) and lessens the burden on the national social security system |
| | Win-win (or win-lose)? | The measure entails side benefits for other social, environmental or economic objectives, especially when it is coupled with the traffic restrictions:<br>• Increased efficiency of public transportation;<br>• Improved air quality in the city |
| | Spill-over effects | This is a no regret option |
| Efficiency/ costs and benefits | Low-regret | The Municipality believes the benefits will clearly outweigh the costs. |
| Framework conditions for decision-making | Equity and legitimacy | All the population groups benefit from the measure, especially vulnerable groups due to their age or poor health conditions as well as people working outdoors.<br><br>This measure is not stipulated in any legislative document. There are only protocols of actions for all the organisations involved in the system. |
| | Feasibility of implementation | There are no significant economic or financial barriers for development and implementation of the Heat Alert System. Though the institutional barriers can be of great significance. The lack of political will and cooperation from population can also be a significant barrier. |
| | Alternatives | None |
| | Monitoring and evaluation | The efficiency of this measure is measured by the dynamics of the excess mortality rate |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | during the heat waves. The dynamics should be negative. |
| | Transferability | The Heart Alert System of Tatabánya can be easily transferred at the low costs. However, the preparation of the protocols for the organisations for the course of actions under the Heat Alert and coordination among them requires much determination, significant political will, a willingness to cooperate from the stakeholders and involves a community perception of the heat waves as a serious threat to the human health under the local conditions. |

**Measure ID: T-3**
**Name of measure: Smart Sun Educational Programme**
**Applied in: Tatabánya (HU)**

**Description:** Under the Smart Sun Educational Programme the different vulnerable groups learn about the harmful effects of the heat waves and high solar activities on the human body as well as about simple and effective measures how to protect oneself and take care of other people (drinking 2-3 litres of still water per day, staying indoors or in shady places, wearing light hats, sun glasses, etc). Adults also learn about their rights concerning the working environment especially if their work includes outdoor activities. The employer should supply employees working outside with drinking water, proper clothing, and should take care of the work regime (1 hour of working outdoor in the heat wave should be followed by 30 minutes' rest ).

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure seeks:<br>• To prevent the harmful impact of high temperatures and high solar activity on human health;<br>• To save resources through enforcing prevention measures instead of dealing |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | with the consequences. |
| | Robustness to uncertainty | Regardless of the extent of the growing severity and frequency of heat waves, the activities presented in the Smart Sun Programme are useful and efficient. |
| | Flexibility | The programme and its contents can be easily modified in accordance with the existing challenges. |
| Side effects | No regret | This is a no-regret option |
| | Win-win (or win-lose)? | The measure contributes to the improvement of productivity in all sectors due to fewer sick leave days (for employees and their children) and lessens the burden on the national social security system |
| | Spill-over effects | This is a no-regret option |
| Efficiency/ costs and benefits | Low-regret | The Municipality believes the benefits will clearly outweigh the costs. Since prevention is by definition less costly than cure. |
| Framework conditions for decision-making | Equity and legitimacy | All the population groups benefit from the measure. They can benefit directly or indirectly. The young people and adults learn how to take care of themselves and those who are less capable (elderly people, small children)<br><br>This measure is a part of the Local Climate Change Action Plan of Tatabánya. |
| | Feasibility of implementation | Highly feasible. The implementation needs cooperation with educational institutions and local businesses. |
| | Alternatives | None |
| | Monitoring and evaluation | The number of training courses carried out and the number of people participating in the trainings. |
| | Transferability | Smart Sun Educational Programme can be easily transferred at low cost. However, the preparation of the content should be tailored to the local conditions. |

**Measure ID: Ve-1**
**Name of measure: City of Venice - Tide Forecasting and Early Warning Centre (Tide Centre)**
**Applied in: City of Venice (IT)**

**Description:**
The Tide Centre allows constant monitoring of the sea level and of meteorological events, thus providing a valuable instrument for climate change adaptation. High tides are predicted and monitored, with forecasts published daily online and in the local newspaper. Information is also available by telephone, text messages and via electronic displays around town. The information listing provides the twice-daily times of high tide and low tide along with the predicted height of water. When high level is predicted, sirens will sound a warning 3-4 hours in advance of high tide, warning residents to prepare homes/commercial activities.

**Applicability Check:**

| **Criterion** | **Indicators/sub-criteria** | **Text** |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | Tide Centre provides flood warning information to citizens of Venice, allowing them to protect their houses and businesses. The measure provides adaptation mostly in terms of reducing impacts of sea level rise. |
| | Flexibility and Robustness to uncertainty | The Centre has been in operation for 30 years now and has been rated as a very successful monitoring and information instrument. |
| Side-effects | No regret | The measure is not related to integrated climate adaptation management, its role is solely to provide information. |
| | Win-win | The information provided is used by citizens, tourists, businesses and city administration (e.g. the city environmental services company is putting boardwalks to make it easier for people to move in the affected areas). |
| | Spill-over effects | No negative effects recognised so far |
| Efficiency/ costs and benefits | Low-regret | The benefits are rated as very high, although they could be further improved if more funds were available (in order to get more and better |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | data). |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | The measure has been developed by the City of Venice, with the involvement of the CNR (Istituto per lo Studio della Dinamica delle Grandi Masse). |
| | Feasibility of implementation | The only issue mentioned is funding. Funds available can be a barrier to the "optimal" implementation of the measure in two ways.<br>1) Much of the data used by the Centre is acquired through contracts with organisations, or, for example, meteorological services in neighbouring Adriatic countries. The Centre could obtain more data if the data which they currently acquire was not so costly.<br>2) The technology necessary for precise forecasting in Venice is very specific. It is a niche sector of meteorology. The City of Venice has participated in working groups with product suppliers but in the end the funds available determine the pace with which the Tide Centre can keep up with the technology available. |
| | Assessment of impacts and alternatives | Not applicable |
| | Monitoring and evaluation | User satisfaction survey was carried out in the year 2000. The Tide Forecasting and Early Warning Centre (Tide Centre) emerged very positively from this initiative. In 2010 the Tide Centre received a prize from the Italian Ministry for Public Administration and Innovation |
| | Transferability | The measure is specifically adapted to the meteorological situation of the City of Venice and therefore is not directly transferable. However, it can be an interesting model for providing early warning information to citizens and businesses, particularly in cities with a high risk of extreme weather events. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Lessons learnt | (linked to transferability) | Although the measure is closely linked to the specific situation of Venice, it could be an example of how to organise early warning systems to protect citizens and the local economy. The Tide Centre has already existed for 30 years but is continuously improving its services, e.g. by introducing a text messaging service or refining its data. |

**Measure ID: Ve-2**
**Name of measure: Urban maintenance for the physical and environmental safeguarding of Venice and the Venetian Lagoon**
**Applied in: City of Venice (IT)**

**Description:**
Urban maintenance activities related to flood protection are carried out by Insula Spa, a company founded in 1997 and owned by the City of Venice and the four main utility companies. Insula's partners are: the City of Venice, with 72.13% of the capital, Veritas spa (with 26.73%) and the Veneto Region (with 1.14%). The interventions were focused mostly on raising urban surfaces, in order to minimise the probability of flooding.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | Urban maintenance activities carried out by Insula help to reduce the impact of extreme weather events and prevent the flooding of the city. The measure provides adaptation mostly in terms of reducing impacts of sea level rise and storm damage. |
| | Flexibility and Robustness to uncertainty | The activities carried out by the company can be adapted to the changing climate risks. Close cooperation with research institutions can also contribute to greater flexibility. |
| Side-effects | No regret | So far the measure does not form a part of an integrated climate adaptation strategy/approach but can be easily integrated, should such a strategy emerge. |
| | Win-win | The measure ensures better conditions for |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | local businesses (minimised impact of flooding), generates employment and contributes to the increased quality of life for the citizens (the establishment of a fund for private citizens to improve their homes from a structural point of view). |
| | Spill-over effects | The only negative effect recognized so far is the temporary inconvenience to the inhabitants of the areas in which Insula is working at the moment (noise etc.) |
| Efficiency/ costs and benefits | Low-regret | The benefits are rated as very high, although it has been mentioned that the changes in financing structure (no more national funds) have made it impossible for Insula to implement all planned activities. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | Insula Spa has been founded to perform the maintenance services, as needed by the city. The establishment of the company engaged a wide range of stakeholders: local and regional government, national government (funding), construction companies and local research institutions. |
| | Feasibility of implementation | Since the discontinuation of the Special Law for Venice in 2005, the activities can no longer be funded from national sources and the City is able to cover only 65% of the budget needed to perform all planned activities.<br>Apart from financial difficulties, there are occasionally also technological difficulties, related to the specific local conditions. Insula Spa has managed to find the relevant technologies, even if sometimes they had to be specifically developed (e.g. for increasing the resistance of canal walls). |
| | Assessment of impacts and alternatives | The measure has positive social and economic side effects, as mentioned above. The current set-up has been selected as responding best to the urgency of the situation. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | Monitoring and evaluation | The activities of Insula Spa are regularly monitored by the external controller and the report is then submitted to the City of Venice. The information regarding ongoing works can be monitored using a dedicated IT system. Additionally, citizens have the possibility to contact Insula, in order to point out problems related to the urban environment. So far the measure has been considered very successful by all stakeholders. |
| | Transferability | The measure is specifically adapted to the meteorological situation of the City of Venice and therefore is not directly transferable. However, it can be an interesting model in terms of organisational set-up for dealing with adaptation-focused urban maintenance. |

**Measure ID: Vi-1**
**Name of measure: Promotion of district cooling projects in Vienna**
**Applied in: Vienna (AT)**

**Description:** The cooling centre Spittelau was completed in 2009. The source is the waste heat from waste incineration and waste heat from combined heat and power. (Similar to district heating). The objective is to establish and implement district cooling to about 200 MW of cooling capacity and to implement the necessary state laws.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The demand for increased comfort and possibly extreme weather conditions such as heat waves create demand for district cooling. The measure contributes to reduced exposure to this type of climate event. |
| | Flexibility and Robustness to | Demand for cooling is independent from climate change as it is also driven by |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | uncertainty | increasing needs for comfort. |
| Side-effects | No regret | This is a no-regrets measure as the demand for cooling is independent from climate change and technology can be easily adapted to new needs. |
| | Win-win | Create synergies with mitigation leading to decreased GHG emissions as the objective is to reduce the reliance on conventional cooling systems (i.e. compression chillers powered with converted electricity from fossil fuels). District cooling is powered through absorption chillers using waste heat (from waste incinerators in Vienna, forest biomass power plant in Simmering, the incinerator at Pfaffenau and geothermal heat in Aspern) in the production of cold air which is transported via pipelines for the purpose of cooling. |
| | Spill-over effects | Less need for imported fossil energy. |
| Efficiency/ costs and benefits | Low-regret | There are no available information about climate costs and sources of funding; however the measure is robust to uncertainty as it works under different climate scenarios, it can also be adapted to changing conditions and carries positive side effects. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | The measure is coordinated by the EU Strategy and Economic Development Department of the city of Vienna (MA 27), the company district heating of Vienna (Fernwärme Wien), the Municipal Energy Efficiency Programme (SEP), Construction Authority (planning requirements in MA 34) and the Austrian Energy Agency as the research institution.<br>The **implementation** of this measure is carried out by the district heating company of Vienna (Fernwärme Wien), Construction and Building Department (MA 34).<br>Disadvantaged or minorities are not targeted in this measure. The measure does not have any gender specific consideration. |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | Feasibility of implementation | Financial and institutional barriers to the implementation. The institutional barriers might limit the extent in which the measure will be implemented, namely the agreement and existence of a political mandate. |
| | Assessment of impacts and alternatives | The advantages of this measure in relation to others are: positive side effects (climate change mitigation, lower dependency of imported fossil fuel), robustness to uncertainty and flexibility as it can be easily adapted to changing conditions. |
| | Monitoring and evaluation | The results of pilot projects were evaluated, with the aim of creating data bases for future projects. Cold absorption technology results in savings that reach 2.5 times the $CO^2$ equivalent of conventional plants. These pilot results are very positive, so are concrete follow-up projects already in the planning process. |
| | Transferability | Implementation of the measure depends on a strong political and regional commitment as the measure demands specific procedures or mandates at the level of the administration and with stakeholders. Applicability depends on various local factors, e.g. existence of a district heating system, local expertise using this system. |
| Lessons learnt | (linked to transferability) | The measure was developed to compensate for the increased cooling demand caused by climate change while saving energy. Critical to the implementation of this action was the initiative of the Climate Change Coordination Office of the City of Vienna and the achievement of political willingness. The degree of acceptance by stakeholders after the pilot studies were implemented is high and as a result all parties are planning new projects. |

**Measure ID: Vi-2**
**Name of measure:**
**Spatial planning to reduce climate change impacts and costs**
**Applied in: Vienna (AT)**

**Description:** Since 2003, planning and information is provided by the City of Vienna for the construction of green roofs. Roof gardens on flat roofs of large industrial and commercial, as well as on private housing roofs.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The objective is to cope with heat waves, enable cooling of buildings, increase the humidity, increase retention of pollutants, improving building insulation and reducing noise emissions. The measure mitigates GHG emissions. |
| | Flexibility and Robustness to uncertainty | The measure is effective under different climate scenarios as the measure can be easily adapted to changing conditions or new research findings. |
| Side-effects | No regret | It is a no-regret measure as no negative consequences are known. |
| | Win-win | • The measure has a positive effect on the delivery of sustainable development, sustainable cities and energy efficient cities.<br>• It contributes to decreasing GHG emissions through increased energy efficiency.<br>• It create business opportunities and employment designing and building roofs<br>• It improves the quality of life as green roofs retain pollutants, increase the humidity inside the building and provide residential green areas. |
| | Spill-over effects | • negatively affect the energy sector as it reduces energy consumption |
| Efficiency/ costs and | Low-regret | Green roofs carry no additional costs to the construction, if we take into account the total |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| benefits | | cost over the life of the building. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | **Participants in the development of the measure:**<br>Vienna government agencies: Vienna Environmental Protection Department (MA 22), Vienna City Gardens Department (MA42), Urban Development and Planning Directorate (MA 18),<br>Research institution: University of Agricultural sciences,<br>NGOs: umweltberatung (http://www.umweltberatung.at/start.asp?b=2530)<br>**Implementers of the measure**:<br>Vienna government agencies: coordination by the Vienna Environmental Protection Department (MA 22), Urban Development and Planning Directorate (MA 18), Construction and Building Management (MA 34).<br>Private sector, disadvantaged or minorities are not targeted in this measure. The measure does not have any gender specific consideration. |
| | Feasibility of implementa-tion | No specific barriers are mentioned. |
| | Assessment of impacts and alternatives | Positive side effects (climate change mitigation, reduced noise, improved quality of life, better air quality) and high flexibility of the measure. |
| | Monitoring and evaluation | There is a monitoring and evaluation procedure. Current evaluation to the process shows high stakeholder acceptance of the project. Funding database and the organisation of symposia on the topic provides data to the monitoring and evaluation process. |
| | Transferability | The geopolitical and cultural context is irrelevant to the potential for replicating the strategy, but political commitment seems to |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | be crucial for a long-term commitment. Technically the expertise required is widely available. The measure demands specific monetary investment and a mandate to the local administration to execute the measure. |
| Lessons learnt | (linked to transferability) | The measure was first developed to enhance the green and open space potential of the city. The measure could be easily transferable to other places, as it has several positive side effects with non-regret potential outcomes. It is reasonably priced, and relatively flexible in its implementation. There is high stakeholder acceptability for the measure. |

**Measure ID: Z-1**
**Name of measure: Renewable Energy strategy of the Municipality of Zaragoza and its 'areas of influence'**
**Applied in: Zaragoza (ES)**

**Description:** The strategy seeks to boost sustainable energy measures and to adapt to increasing temperatures (urban heat island effect). It proposes to double the installation of REs (from 150 to 300 MW) through the building of two big RE blocks: 86 MW of thermoelectric PV, and 64 MW of wind parks.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | • Measure seeks to create an overarching approach to energy from a sustainability point of view. One important branch of it is to educate citizens on the subject.<br>• The measure reduces impacts, creates awareness and resilience in the citizenry and improves the energy management system. |
| | Flexibility and Robustness to uncertainty | The measure is effective under different climate and socio-economic scenarios. It intends to generate energy in a less costly and more sustainable way and |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | relying less on fossil fuels and more on renewable sources. |
| Side-effects | No regret | The measure is not necessarily foreseen to contribute directly to a more integrated climate adaptation management.<br>On the other hand it is expected to have considerable positive effects in alleviating existing environmental problems (by reducing the consumption of resources, improving air quality, etc). |
| | Win-win | The strategy creates synergies with mitigation by reducing present consumption of resources and increasing, e.g. air quality—with positive health effects, thereby also improving the citizens' quality of life.<br>It can create business and employment opportunities at local level by bringing the energy generation facilities to the Municipality and its areas of influence. Likewise, other sectors, such as construction and business, could be positively affected as the city's sustainable approach attracts newcomers. |
| | Spill-over effects | No negative side effects expected. Regarding the opposition to the installation of RE from an aesthetic point of view, the lead administrative body feels that the majority of citizens do not see this as a problem. |
| Efficiency/ costs and benefits | Low-regret | The Municipality believes the benefits will clearly outweigh the costs. Private developers are expected to play a key role by investing in the plans set out by the Municipality (thermoelectric PV and wind parks). |
| Procedural aspects and | Equity and legitimacy | Actions are formally conducted, welcoming stakeholder review and |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| framework conditions for decision-making | | allowing citizens' inputs.<br>Conventional power generation companies may be negatively affected unless they take part (invest) in the Municipality's RE plans. |
| | Feasibility of implementation | Institutional barriers have been encountered. Getting other departments within the LG to work cross-sectorally has proved to be very difficult. Coordination becomes tough and time consuming.<br>High dependence on private investment may be an obstacle. |
| | Assessment of impacts and alternatives | This measure is considered to be advantageous in the following areas:<br>• Robustness to uncertainty<br>• Positive side effects<br>• Absence of negative side effects<br>• Cost-benefit ratio (assumes investor buy-in)<br>• Feasibility of implementation (partly assumes investor buy-in)<br>• Equity and legitimacy |
| | Monitoring and evaluation | A formal monitoring of sustainability indicators (RE installed capacity as percentage to conventional installed capacity, and $CO_2$ emissions levels) is conducted. |
| | Transferability | The geopolitical and cultural context is irrelevant to the potential for replicating the strategy. Certain legislative requirements need to be in place, such as access to the grid. Availability of idle land is important, as it offers potential installation grounds for RE sources. In this sense, climatic conditions can be a limiting factor.<br>Political commitment is crucial to forming a long-term commitment. |
| Lessons learnt | (linked to | Again, political commitment and drive |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | transferability) | play a crucial role in developing and materialising the strategy.<br>Cost savings are not obvious, and indeed they rely heavily on private investor interest.<br>There is a feel of 'stakeholder acceptance', though measures mostly do not affect the average citizen in an obvious way. |

**Measure ID: Z-2**
**Name of measure: Create a strategy to introduce policies for saving water and to improve the water quality in order to adapt to unfavourable conditions.**
**Applied in: Zaragoza (ES)**

**Description:** To cope with the scarcity and low quality of the available resource, the Municipality takes an overarching approach that tackles reduced water consumption, improved water quality, and solutions to bring water from nearby areas.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness of adaptation | Adaptation function | The measure seeks to reduce water consumption and to improve the quality of water available in response to deteriorating conditions. It reduces impacts, creates awareness and resilience in the citizenry and improves the water management systems. |
| | Flexibility and Robustness to uncertainty | The measure intends to cope with worsening climate scenarios, such as less frequent but stronger precipitation events.<br>Whether climate changing conditions exceed or fall short of predictions, the measure will deliver benefits to the area and its citizens. |
| Side-effects | No regret | More integrated climate adaptation management is expected, resulting from the experience of several departments and outside |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | actors cooperating for the preparation and implementation of the strategy. |
| | Win-win | The strategy creates synergies with mitigation by for example reducing present consumption of water and increasing its quality—with positive health effects, thereby also improving the citizens' quality of life.<br>It is likely to serve as a learning experience within the LG to increase departmental interaction and lead to an enhanced cross-sectoral approach to operations. |
| | Spill-over effects | The part of the strategy related to increased withdrawals from the Pyrenees reservoir may have potential negative effects, both during the works of expanding the reservoir and during the use phase. |
| Efficiency/ costs and benefits | Low-regret | The Municipality believes the benefits will clearly outweigh the costs. It aims to have a reasonably short pay-back time. |
| Procedural aspects and framework conditions for decision-making | Equity and legitimacy | Stakeholder involvement actions are formally conducted, allowing citizens' inputs and welcoming debate.<br>Analysis is systematically conducted aimed at reducing potential negative impacts. |
| | Feasibility of implementation | The Municipality has not encountered major barriers to implementation. |
| | Assessment of impacts and alternatives | Measures have been carefully analysed internally prior to their implementation. Economic studies have been conducted and information campaigns and stakeholder involvement processes have been put in place. Campaigns to raise awareness to reduce water consumption by households and businesses are considered important given their potential effect and the long-term value of educating the population. |
| | Monitoring and evaluation | Water quality and water consumption levels are monitored.<br>Tariffs may be adjusted annually to keep on track towards targets. |
| | Transferability | The case of Zaragoza shows that (relative) |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | urgency can trigger a successful outcome. As the quality and availability of water in Zaragoza are both poor, actions have been implemented on many fronts and the combination has borne fruit.<br>The measures applied in Zaragoza have the potential to be applicable in any geographical location, however especially where similar needs and constraints exist re water availability. Having an expert department (or agency, as in this case) assigned the mission to implement, monitor and evaluate the strategy is likely to have contributed to the effectiveness of the process. |
| Lessons learnt | (linked to transferability) | A determined lead administrative body and overwhelming political support have contributed to the positive outcome of the strategy, as well as active involvement from several actors (other departments of the LG, universities, business, citizens, NGOs).<br>There is little, if any, innovativeness in these measures; the overarching approach, however, is crucial. |

**Measure ID: Z-3**
**Name of measure: Protecting biodiversity – Favour the richness of the existing ecosystems with very different characteristics within the Municipality**
**Applied in: Zaragoza (ES)**

**Description:** The measure focuses on protecting the fauna and flora of the Municipality, with emphasis on a plan to protect the steppe, and a plan to control invasive species which are having a devastating effect on endemic species.

**Applicability Check:**

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| Effectiveness | Adaptation | The measures included in the Municipality's |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| of adaptation | function | biodiversity plan are a reaction to the deteriorating situation of a portion of the area's biodiversity. It intends to revert the negative conditions faced by threatened and endangered endemic species, and thus support the stability of the ecosystem and the services it provides. |
| | Flexibility and Robustness to uncertainty | The measures are aimed at creating positive conditions in order to alter adverse situations. In this sense, the measures counteract factors deteriorating the ecosystems as well as climate change. |
| Side-effects | No regret | The measures foster more integrated climate adaptation management and bring benefits in terms of also alleviating already existing environmental problems. They have the potential to bring social (e.g. conservation of green areas and fauna and flora, with related increased quality of life) and economic benefits (e.g. ecotourism). |
| | Win-win | The measures grouped under protecting the biodiversity:<br>• contribute to the population's quality of life.<br>• positively affect other sectors. |
| | Spill-over effects | It is unlikely that the measures would negatively affect other sectors or agents in terms of their adaptive capacity, or that they would exacerbate other environmental pressures. |
| Efficiency/ costs and benefits | Low-regret | While monetising the benefits of protecting biodiversity is complex and to an extent subjective, conceptually it is likely that the benefits in the long term will outweigh the costs.<br>Each measure should then be considered individually to determine whether it is efficient with regards to costs and benefits. |
| Procedural aspects and framework | Equity and legitimacy | Local authorities identify areas of concern and develop measures to improve the particular situation. Expertise is necessary to |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| conditions for decision-making | | understand ecological processes that are being put under pressure by outside factors, as well as to envision a potential solution.<br>Input from NGOs specialised in biodiversity is taken into consideration. |
| | Feasibility of implementation | What barriers are there to implementation?<br>• Social: Certain actions affect private landowners when the land in question (the majority of land affected is agricultural) is made 'off-limits' or of 'restricted entrance' for the sake of protecting protect biodiversity.<br>• Environmental: Lack of, or limited, knowledge and inability to forecast certain ecological processes.<br>National and European legislation determine particular species that need to be protected. The Municipality is required to comply with these mandates. Additionally it is entitled to and does develop and implement plans based on its own concerns (protection of additional species or areas, for example) |
| | Assessment of impacts and alternatives | In some cases, restrictions to use of or access to land impacts landowners or citizens looking to use the land for leisure. Impacts are, therefore, felt in the short term, with expected benefits in the longer term. |
| | Monitoring and evaluation | Measures are monitored through regular follow-up and the use of biodiversity indicators, such as:<br>- Presence/absence of species.<br>- Diversity and density of species population.<br>- Surface subject to a certain degree of protection. |
| | Transferability | The unique characteristics of the fauna and flora of the region (and of any region) make the transferability of the measures naturally very low.<br>A high level of expertise in local biodiversity and ecosystems in general is required in order |

| Criterion | Indicators/sub-criteria | Text |
|---|---|---|
| | | to correctly identify the needs for action and to propose adequate solutions.<br>Close cooperation with national bodies is required to maintain congruence in the actions being undertaken. |
| Lessons learnt | (linked to transferability) | Key measures to protect biodiversity in Zaragoza are a combination of mandates from national and European bodies and expert analysis and advice from the local expert division of the Municipality's Agency of Environment and Sustainability. The existence of this agency facilitates the process and gives it credibility.<br>Communication with stakeholders and raising awareness of the importance and value of protecting ecosystem processes is crucial. Similarly, political commitment and support for these actions is important from both legitimacy and financial standpoints. |

# Annex 6: List of Interviewees

We would like to thank all our interview partners for their kind cooperation. Interviews with representatives of local institutions have been an important source of information for the study and we are grateful for their input. The final information presented, opinions expressed and in particular any errors in content are, however, the full responsibility of the authors from the contributing institutions, i.e. Ecologic Institute, AEA, ICLEI and REC.

| Case study | Interviewee(s) and their Institution | Date(s) of Interview |
|---|---|---|
| Dresden | Peter Teichmann, Landeshauptstadt Dresden – Umweltamt | 26.02.2010 |
| | Reinhard Niespor, DREWAG Stadtwerke Dresden GmbH | 14.4.2010<br>16.04.2010 |
| | Matthias Röder, Landeshauptstadt Dresden – Umweltamt, Abt. kommunaler Umweltschutz, SG Gewässer- und Bodenpflege | 23.04.2010 |
| | Michael Weiß, Abteilungsleiter Betrieb Wasserwerke, DREWAG Stadtwerke Dresden GmbH | 11.06.2010 |
| Hamburg | Helga Schenk, Freie und Hansestadt Hamburg – Behörde für Stadtentwicklung und Umwelt | 05.03.2010<br>11.03.2010 |
| | Axel Waldhoff, Leiter Regenwassermanagement, Hamburg Wasser – Hamburger Stadtentwässerung AöR | 27.05.2010 |
| Lyon | Régis Meyer, Political Adviser, Sustainability and Climate Change, Grand Lyon Communauté Urbaine | 25.02.2010,<br>09.03.2010 |
| | Frederic Segur, Head of Unit, Trees and Landscape in Public Spaces, Grand Lyon Communauté Urbaine | 21.04.2010 |
| Vienna | Sylvia Berndorfer, City of Vienna, Magistratsdirektion Klimaschutzkoordination | 01.03.2010<br>12.04.2010 |
| Almada | Joao Cleto, Agência Municipal de Energia de Almada (AGENEAL) | 01.03.2010<br>13.04.2010 |
| London | Alex Nickson, Strategy Manager for Climate Change Adaptation and Water, | 09.02.2010 |

| Case study | Interviewee(s) and their Institution | Date(s) of Interview |
|---|---|---|
| | Greater London Authority | |
| | Louise Clancy, Environment Programme Officer, Greater London Authority | 26.03.2010 |
| | Matt Thomas, Urban Greening Transport and Environment Greater London Authority | 31.03.2010 |
| Manchester | Corin Bell, National Indicator 188 lead, Manchester City Council | 25.01.2010 |
| | Dr Sarah Lindley, Manchester University | 01.03.2010 |
| | Jeremy Carter, Manchester University | 15.03.2010 |
| Venice | Jane Wallace-Jones, Comune di Venezia | 11.03.2010 |
| Birmingham | Richard Rees, Climate Change and Sustainability Department | 18.03.2010 |
| | David Ward, Sustainability Manager, Climate Change and Sustainability Department, Birmingham City Council | 17.06.2010<br>22.06.2010 |
| Copenhagen | Lykke Leonardsen, City of Copenhagen – Technical and Environmental Administration, Centre for Park and Nature | 12.03.2010 |
| | Jan Rasmussen, Project Manager, The Technical and Environmental Administration, City of Copenhagen | 15.06.2010<br>28.06.2010 |
| Bremen | Andreas LieberumForschungsprojekt "nordwest2050" Sustainability Center Bremen | 24.02.2010<br>18.06.2010 |
| Helsinki | Pauliina Jalonen, Environment Centre City of Helsinki | 08.03.2010<br>27.05.2010 |
| Bologna | Giovanni Fini<br>Dirigente Responsabile U.I. Qualità Ambi entale<br>Dipartimento Qualità della Città<br>Settore Ambiente<br>Comune di Bologna | 23.03.2010<br>15.06.2010 |
| Zaragoza | Javier Celma, Carmen Cebrian and Luis Manso<br>Local Agency for Sustainability and Environment | 15.02.2010<br>15.04.2010<br>01.06.2010<br>08.06.2010 |

| Case study | Interviewee(s) and their Institution | Date(s) of Interview |
|---|---|---|
| | | 14.06.2010 |
| Amsterdam | Camiel van Drimmelen<br>Urban Planning, Water Management | 11.03.2010 |
| Prague | Ing. Jiří Cabrnoch, Csc.Vodohospodářský rozvoj a výstavba a.s. | 12.03. 2010<br>25.04.2010 |
| Tatabanya | Andras Olah, Municipality of City of Tatabánya, Department for Strategy and Control | 13.03. 2010<br>20.04. 2010<br>20.06.2010 |
| Riga | Ieva Bruneniece<br>Climate Change and Adaptation Expert, University of Latvia | 12.03. 2010 |
| Stockholm | Gustaf Landahl<br>City of Stockholm, Environment and Health Department | 19.03.2010<br>27.05.2010<br>14.06.2010 |
| | Staffan Lorentz<br>Head of Development<br>Stockholm Royal Seaport | 04.06.2010 |
| Budapest | Dr Anna Paldy<br>National Institute of Environmental Health | 12.04.2010<br>01.07.2010 |