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Adaptation to climate change using green and blue infrastructure

A database of case studies

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grabs
green and blue space adaptation for urban areas and eco towns

INTERREG IVC

Database prepared by Aleksandra Kazmierczak and Jeremy Carter (University of Manchester) for the Interreg IVC Green and blue space adaptation for urban areas and eco towns (GRaBS) project.

Cover photograph by Aleksandra Kazmierczak: Millennium Park in Chicago, USA

Maps for case studies: Chicago, Dorset, Nagoya, New Orleans, Seattle and Toronto by Gina Cavan.

Maps for case studies: Basel, Berlin, Faenza, Malmö, North West England, Slovakia, Stuttgart, Sutton and the Netherlands by Jack Dods.

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Executive summary

The aim of this database of case studies is to showcase climate change adaptation approaches, with a particular emphasis on those relating to green and blue infrastructure. The database is an important deliverable of the GRaBS project[1]. Rather than focus on the physical elements of the case studies, the database describes in detail the process that have supported the implementation of adaptation responses in a range of urban areas across the world. The case studies therefore identify and highlight key factors in different areas (e.g. governance, stakeholder relationships, science and research) that influenced the success of adaptation responses in different locations. It is hoped that the database will meet an important need in terms of progressing green and blue infrastructure adaptation responses, and will act as a valuable resource for a wide range of stakeholder communities engaged in these activities.

Analysis of previous studies on factors influencing the success of the development and implementation of adaptation responses (chapter 2) highlights the following significant issues:

- Collaboration with external stakeholders
- Strong leadership or championship
- Access to funding
- Awareness levels within the organisation
- Outsourcing research and other actions
- Human resources and skills
- Public awareness and engagement
- Quality and availability of information and data
- Position of adaptation on the list of priorities
- Development of local regulations and policies.

The strengths, weaknesses, opportunities, and threats (SWOT) that characterise and face the partner organisations participating in the GRaBS project during their preparation of adaptation responses using green and blue infrastructure (chapter 2) link closely to factors identified in previous studies. The crucial factors were as follows:

- Regulations and policy at the local level
- Access to and quality of data and information
- Cross-departmental collaboration
- Public engagement
- Policy framework at higher levels (national and regional)
- Collaboration with external stakeholders
- Access to funding
- Learning from others (networking, research projects)
- Need for urban development or regeneration
- Existence of a strong sustainability movement
- Public awareness
- Current green space resources.

The results of these two exercises, supplemented by a questionnaire survey gauging the interest of GRaBS partners in different climate change impacts and forms of adaptation response to be explored during the project, guided the selection of the 15 in-depth case studies presented in chapter 3. The case studies were selected from around the world, although a focus was maintained on subject matter relevant to European conditions.

[1] The Interreg IVC Green and Blue Space Adaptation for Urban Areas and Eco Towns project (GRaBS) aims to improve the regional decision and policy making process in relation to the planning and development of new and existing urban areas in eight EU member states in the context of climate change. The project aims to facilitate the much needed exchange of knowledge and experience and the actual transfer of good practice on climate change adaptation strategies to local and regional authorities. More information is available at: www.grabs-eu.org

The case studies are as follows:

- Toronto: Ahead of the storm – development of the climate change adaptation action plan
- The Netherlands Live with Water: Public awareness raising campaign
- Stuttgart: Combating heat island and poor air quality with green aeration corridors
- Slovakia: Development of open space standards
- Seattle: Using vegetation to limit the hazard of landslides
- New Orleans: preserving the wetlands to increase climate change resilience
- Faenza: Extra cubature for developers in return for green space
- Dorset: Financial contributions of planning applications for prevention of heathland fires
- Berlin: The Biotope Area Factor
- Augustenborg in Malmö: Retrofitting SUDS in an urban regeneration area
- A Climate Change Action Plan for North West England: exploring the position of green infrastructure
- Basel: Building regulations for green roofs
- Chicago: Green Permit Program – incentives for developers to install green roofs
- London Borough of Sutton: Adaptation to flooding via local planning policies
- Nagoya: Adaptation to climate change driven by biodiversity conservation

Each case study offers a description of the geographical location, themes driving the initiative, details of the development and implementation of the initiative, as well as a discussion of the potential of the initiative to deliver climate change adaptation benefits and other positive impacts. There follows a brief summary of each case study.

Toronto: Ahead of the storm – development of the climate change adaptation action plan

In 2008, the City of Toronto became one of the first cities in Canada to develop a comprehensive climate change adaptation strategy. The document, titled *Ahead of the Storm*, details a number of short and long-term actions to adapt Toronto to projected more frequent and more severe heatwaves and flooding. The Strategy highlights the importance of investment in storm water management and in parks and urban forests. The implementation of the actions in the strategy is still at an early stage, and this case study focuses on the process of developing the strategy by the local authorities in Toronto. This included the formation of an inter-departmental Adaptation Steering Group, raising awareness among staff, development of short and long-term adaptation strategies, extensive public consultation, and inclusion of the adaptive actions in budgets of the relevant departments of the City.

The Netherlands Live with Water: Public awareness raising campaign

The climate change projections for the Netherlands project an increased risk of coastal and river flooding. It was acknowledged in 2000 that the current water management system based on technological solutions is inadequate, and that more space needs to be made for water. It was also recognised that citizens do not sufficiently recognise and acknowledge the potential problems associated with water. Consequently, in 2003 "The Netherlands Live with Water" public awareness campaign was launched. The campaign emphasises the need to store water along both the main national and regional water management systems during times of excessive rainfall or high levels of river discharge. It also promotes the actions that individuals can do themselves to help reduce the threat of flooding. The campaign has used the Netherlands favourite weather presenter as their spokesman. Independent reviewers have assessed the campaign as being an effective awareness raising approach.

Stuttgart: Combating heat island and poor air quality with green aeration corridors

Stuttgart's location in a valley basin, its mild climate, low winds and surrounding industrial activity has made it susceptible to poor air quality since the 1970s. Development on the valley slopes have made the situation worse by preventing air from moving through the city, which contributes to the urban heat island effect. Consequently, Stuttgart has been planned to exploit the role of natural wind patterns and dense vegetation in reducing problems of overheating and air pollution. A

Climate Atlas was developed for the Stuttgart region, presenting the distribution of temperature and cold air flows according to the city's topography and land use. Based on this information, a number of planning and zoning regulations are recommended which aim to preserve open space and increase the presence of vegetation in densely built-up areas. The planning recommendations build on the legislative framework of the German Building Code and other national, regional and locally developed regulations.

Slovakia: Development of open space standards

In Slovakia, the Ministry for Construction and Regional Development commissioned a group of experts in 2009 to update the set of national standards for land use planning, which were first developed in 2002. The standards include guidance for planning of open spaces and green areas. The standards describe not only the aspects relating to the quantity of open space in towns or in a given development, but also include aspects relating to the quality and character of open spaces, such as percentage of sealed surfaces, percentage of tree cover and accessibility. This exhaustive set of standards builds on examples from other European cities, including Berlin, Graz, and Malmö. The standards will be adopted by the Slovakian Ministry for Construction and Regional Development in December 2010 and will provide a non-statutory guidance for spatial planners and other departments in local authorities when taking decisions relating to land use planning and development control.

Seattle: Using vegetation to limit the hazard of landslides

Landslides are a widespread, frequent, and costly hazard in Seattle (Washington State, USA) due to the area's post-glacial geology, topography characterised by steep slopes, and climate with wet winters and frequent rain showers. Climate change is likely to increase ground instability in the area by exceeding the safe saturation levels of soil through more frequent and intense precipitation. After disastrous landslides in winters of 1995-96 and 1996-97, the City of Seattle in collaboration with the US Geological Survey and the State of Washington has carried out extensive research to identify the areas prone to landslides, and issued regulations on how landslide risk could be prevented. The regulations within the Seattle Municipal Code include detailed requirements on the maintenance and restoration of vegetation in areas prone to landslides. These regulations are also presented by the Department for Planning and Development to Seattle residents in form of user-friendly "Client Assistance Memos" and through public meetings.

New Orleans: preserving the wetlands to increase climate change resilience

Following the disastrous failure of structural flood defences during Hurricane Katrina in 2005, the State of Louisiana and the City of New Orleans have undertaken steps to increase the resilience of the city to sea level rise, hurricanes and river flooding. An approach utilising many lines of defence has been adopted, involving structural and non-structural defences. One of the key protection measures is the conservation and restoration of wetlands as a buffer zone between the sea and the city. Detailed actions aimed at the promotion of wetlands are included in the New Orleans Masterplan under the headings of green infrastructure and city resilience. Inclusion of wetland conservation and restoration activities in the New Orleans Masterplan signals a significant change of flood-defence tactics in the region from an emphasis on levees and floodgates to the incorporation of more natural solutions. The focus on wetlands as a natural buffer responds to the calls of research emphasising the importance of wetlands in flood protection.

Faenza: Extra cubature for developers in return for green space

The Municipality of Faenza has implemented a bio-neighbourhood incentive programme for developers. This is included in their Town Planning Regulations. The incentive programme aims to achieve energy savings, promote aesthetic qualities of neighbourhoods, and also create better microclimate conditions to prepare for future rising temperatures associated with climate change. The incentive programme allows developers to extend the cubature of buildings in bio-neighbourhoods in excess of approved standards, if the buildings meet certain criteria of environmental sustainability. These include green roofs, green walls and water retention systems, and also the creation of continuous public green spaces by developers. The unique characteristic

of the regulations is that there are no set standards, with the development conditions negotiated on case-by-case basis. The negotiations between town authorities and developers or housing associations significantly shorten the wait for building permits to be obtained therefore providing an incentive to engage in the scheme, and in addition engage a wider range of stakeholders into the town planning process.

Dorset: Financial contributions of planning applications for prevention of heathland fires

The Dorset Heathlands cover an extensive area of South East Dorset, England, and are fragmented by urban development and other land uses. Heathlands are an important habitat and are protected by European-level designations. They are prone to fires, and this risk is likely to increase with climate change, causing habitat loss and putting the fire rescue service under considerable pressure. Development nearby protected sites significantly increases the risk of fires and other negative impacts on the heath such as loss of biodiversity. With these issues in mind, a Joint Interim Planning Framework was agreed in 2007 by South East Dorset local authorities to cover all protected heathland across South East Dorset. It seeks to secure developer contributions toward funding the implementation of a package of mitigation measures to offset the adverse effects of additional residential development on the heathlands. The framework applies to all new housing that results in a net gain in dwelling units within a zone between 400m and 5km of designated European wildlife sites, and no development is permitted within a 400m buffer around heathland sites.

Berlin: The Biotope Area Factor

In Berlin, plans for the development of new buildings now fall under a regulation that requires a certain proportion of the development area to be left as a green space. The proportion of green space to the entire development area is referred to as the Biotope Area Factor (BAF or BFF for *Biotop Flächenfaktor*). The regulation is a part of a larger suite of documents relating to landscape planning, landscape design and species protection. It responds to the need to encourage more green space areas to be developed in densely built-up urban locations. An important advantage of the BAF regulation is that it allows flexibility of the site design; the developer may decide what green space measures are applied, and where, as long as the required green space ratio is achieved. The Biotope Area Factor has generated a significant international interest.

Augustenborg in Malmö: Retrofitting SUDS in an urban regeneration area

The neighbourhood of Augustenborg (Malmö, Sweden) has experienced periods of socio-economic decline in recent decades, and frequently suffered from floods caused by overflowing drainage systems. Augustenborg underwent a significant regeneration between 1998 and 2002. The main drivers for this regeneration initiative were the difficult social and economic situation in the neighbourhood, flood risk management, waste management and biodiversity improvement. Significant physical changes in infrastructure took place as a result, focusing on the creation of sustainable urban drainage systems, including ditches, retention ponds, green roofs and green spaces. The project was carried out collaboratively by the city council and a social housing company, with extensive participation of the residents in Augustenborg. The project has resulted in a successful outcome as the rainwater runoff rates have decreased by half, and the increase in green space has improved the image of the area.

A Climate Change Action Plan for North West England: exploring the position of green infrastructure

In North West England a regional Climate Change Action Plan was first developed for the years 2007-2009. This was then refreshed in February 2010 for the years 2010-2012. The objective of the revised Climate Change Action Plan is not to replace, but to strengthen the vision of a low-carbon and well adapted region, taking into account progress made to date and developments at national and international levels. Green infrastructure plays a prominent role in the plan, both in terms of its role in climate change mitigation and adaptation. Indeed, one of the stated actions is a "regional assessment of the risks, opportunities and priorities for green infrastructure in adapting

and mitigating for climate change". This work is being undertaken as part of the Interreg IVC GRaBS project. The strong position of green infrastructure in the plan reflects a history of research on the subject in the region, as well as a coordinated and structured effort by professionals to embed green infrastructure into regional policy, which has facilitated the inclusion of the concept in statutory regional strategy documents. Key lessons offered by this case study include the significant role of collaborative working during the development of the action plan, and previously in the region on the promotion of green infrastructure including the use of economic arguments to support green infrastructure actions.

Basel: Building regulations for green roofs

The city of Basel in Switzerland has the highest area of green roofs per capita in the world. The use of green roofs has been stimulated by a combination of financial incentives and building regulations. Building regulations have required the use of vegetation on roofs since their implementation in 2002. Initiatives aiming to increase the provision of green roofs in Basel were initially driven by energy-saving programmes, and subsequently by biodiversity conservation. The focus on green roofs was promoted by the researchers from the Zurich University of Applied Sciences in Wädenswil, Switzerland, who worked to influence decision-makers in Basel to amend the building regulations and offer financial incentives to increase green roof coverage.

Chicago: Green Permit Program – incentives for developers to install green roofs

Chicago's Department of Buildings has developed an incentive program that encourages developers to incorporate environmentally conscious design elements, including green roofs on new buildings. This is known as the Green Permit Program. The incentive is an expedited permit process, through which developers can save both time and money. The initiative is a part of larger portfolio of initiatives aimed at making Chicago's built environment greener and more sustainable. The Green Permit Program was made possible due to the strong leadership of the Chicago Mayor and the efficient processing of the applications by the DOB. Additional benefits of the Green Permit Programme include mitigation of climate change through reduced need for heating and cooling in buildings with green roofs, enhancing the image of the city and the emergence of businesses specialising in green roof installation.

London Borough of Sutton: Adaptation to flooding via local planning policies

The London Borough of Sutton, a local planning authority located in the South East of England, has prepared a range of innovative spatial planning policies that seek to ensure future development within Sutton is fully adapted to the impacts of climate change. Whilst impacts such as temperature rise and occurrence of heat waves are also covered by these policies, this case study focuses on how spatial planning policies have been developed to address the risk of all forms of flooding to and from new developments, and to promote the role of sustainable urban drainage systems in managing surface water runoff. Flooding has already caused significant damage in parts of the Borough, and climate change is projected to further increase the frequency and intensity of flood events. The case of Sutton offers valuable lessons on the development of planning policies targeting adaptation to flooding. These include the use of a robust evidence base to develop policy, and the engagement of local stakeholders and residents in the planning process.

Nagoya: Adaptation to climate change driven by biodiversity conservation

Changes in land use associated with industrialisation and the expansion of residential areas have reduced green sites in Nagoya to about 25% of the area of the city. An additional cause of concern is the increase in temperature of Nagoya City associated with climate change. These factors are exacerbating the urban heat island effect and problems associated with high temperatures in the urban areas of Nagoya. Given these threats, the City of Nagoya has undertaken various measures to create more sustainable lifestyles in the city. The main initiative that can help the city become better adapted to climate change (in particular to high temperatures) is the 2050 Nagoya Strategy for Biodiversity, which aims to improve and extend the green areas of the city. Sitting within the Biodiversity Strategy, the Water Revitalisation Plan aims to recharge ground water supplies by increasing infiltration through the use of green spaces. A

crucial aspect of the Biodiversity Strategy is its implementation in close collaboration with the city's residents, business and non-governmental organisations.

A range of lessons have been extracted from the 15 case studies described in this report (chapter 4). These have been organised according to issues relating to climate change adaptation planning and decision making. The issues covered relate to the process of adaptation planning and decision making, for example collaborative working and developing a sound evidence base, rather than guidance for adaptation actions such as green roof techniques. As the lessons are generic, they are broadly transferable across sectors and spatial scales. The lessons are accompanied by practical 'tips' that suggest ways in which organisations can incorporate these issues into climate change adaptation planning and decision making.

Lessons relate to the following issues:

- Triggers for action, or the reasons why an action is considered by the organisation
- Continuing leadership and championship
- Raising awareness within the organisation, amongst stakeholders and with the wider public
- Collaborative working; how internal and external collaboration, and in particular cooperation with research institutes, has facilitated a stronger adaptation response
- Learning from others, in terms of adaptation processes and/or adaptation actions
- Developing a sound evidence base, either using in-house expertise or by outsourcing experts
- Public engagement on adaptation issues
- Embedding adaptation in decision making through policies, plans, regulations or incentives, and via close collaboration with developers
- Funding for adaptation responses
- Monitoring and evaluation of adaptation responses

The database is supplemented by a number of short (1-page) case studies in Appendix 1, and other sources of practical examples and advice on the preparation of adaptation responses with the use of green and blue infrastructure are listed in Appendix 2.

Table of contents

1 Introduction

1.1 The structure of the report

This report is organised into five distinct sections:

- Chapter 1: Introduction. This explains the key aims of the database, and provides information about the approach taken to the selection of the case studies.
- Chapter 2: Factors affecting adaptation actions at the local level. This chapter summarises important factors recognised by previous research that influence the success of embedding adaptation to climate change in decision making. It also presents a summary of challenges and opportunities to the development of green and blue infrastructure adaptation responses, as identified by organisations participating in the GRaBS project. This discussion also identifies aspects of developing adaptation responses that the GRaBS partners were interested in learning more about, which helped to guide the case study selection process.
- Chapter 3: Case studies. This chapter begins with a table presenting the distribution of case studies against the criteria that were used to select the case studies. The structure of the case studies is briefly explained. The main part of this chapter, and of the overall report, is 15 in-depth case studies presenting different approaches to adaptation to climate change which utilise green and blue infrastructure.
- Chapter 4: Lessons learnt. This chapter summarises the lessons learnt from the case studies and aims to draw generic and transferable lessons that practitioners and decision makers can draw upon when developing climate change adaptation responses.
- The appendices, which include 18 short case studies highlighting additional examples of green and blue infrastructure approaches (Appendix 1), and a list of other sources where case studies on adaptation to climate change using green and blue spaces can be found (Appendix 2).

1.2 The aim of the database

Climate change adaptation case study databases, particularly those relating to green and blue infrastructure, often focus on the physical elements of new developments or modifications to the built or natural environment. Examples of adaptation actions include green roofs, sustainable drainage systems or urban tree planting projects. Actions such as these may be supported by wider capacity building exercises, such as legislation, planning strategies and guidance, which help to provide a framework to support their implementation. Capacity building approaches relating to developing such frameworks are sometimes presented as case studies, although generally not as often as the adaptation actions themselves. Therefore, this database focuses predominantly on capacity building approaches needed to support the development of adaptation actions 'on-the-ground'. However, other useful sources of information about green and blue infrastructure adaptation responses are signposted in the database (see Appendices 1 and 2).

The aim of this database of case studies is to showcase climate change adaptation approaches, with a particular emphasis on those relating to green and blue infrastructure. Rather than focus on the physical elements of the case studies, the database describes in detail the process that have supported the implementation of adaptation responses in a range of urban areas across the world. The case studies therefore identify and highlight key factors in different areas (e.g. governance, stakeholder relationships, science and research) that influenced the success of adaptation responses in different locations. It is hoped that the database will meet an important need in terms of progressing green and blue infrastructure adaptation responses, and will act as a valuable resource for a wide range of stakeholder communities engaged in these activities.

1.3 Selection of the case studies

The data to populate this case study database has been collected via a number of methods:

- Desk based review of existing case study databases and contacts with relevant stakeholder networks. This helped to gather basic information about potential case studies.
- Interviews and email exchanges with the individuals involved in the process of development of adaptation responses linked to the selected case studies. This provided in-depth knowledge about the adaptation initiatives and helped to identify key learning points.
- Online survey including a short template for information about suggested case studies, which was emailed to the GRaBS project partners, international, national and regional stakeholder networks of the University of Manchester, the Town and Country Planning Association, Commission for Architecture and the Built Environment and the UK Climate Impacts Programme. Many of the case studies included in Appendix 1 were provided by survey respondents.

2 Factors affecting adaptation actions at the local level

The case studies included within this database have been selected from all over the world, although a focus on the European context was maintained due to this being the location of the GRaBS project partners. The selection of the 15 in-depth case studies was guided by consideration of a number of different aspects of adaptation responses, which were developed into a series of selection criteria that the case studies needed to meet in order to be included. The selection of case studies according to these criteria is presented in Table 4. The selection criteria incorporated an analysis of challenges and opportunities associated with preparation of adaptation responses (based on an assessment of previous research and input from GRaBS project partners). It was established that collectively, the case studies included in database would address each of these key challenges and opportunities to the development of green and blue adaptation responses, which are described below.

2.1 Previous research

The barriers to formulation and implementation of adaptation action plans and responses in general, not only those focusing on the use of green and blue spaces, have not been analysed extensively to date. However, there are some relevant examples. In England, CAG consultants analysed 27 case studies of local planning authorities (municipalities) aiming to achieve the standards required by National Indicator 188: Planning to Adapt to Climate. The Chartered Institution of Water and Environmental Management, at the end of a conference on Integrated Urban Drainage in 2006, asked delegates for their views on key barriers to the implementation of Integrated Urban Drainage Systems, including SUDS, in the United Kingdom. In Penrith, Australia, interviews were conducted in 2009 with eleven senior Council managers to identify barriers preventing the Council from implementing climate change adaptation plans. The Clean Air Partnership investigated climate change adaptation plans in six urban regions: London, New York, Boston, Halifax, Greater Vancouver, and Seattle and King County. In addition, the drivers and barriers for adaptation in ten cities in the global south (Beijing, Cape Town, Hong Kong, Yogyakarta, New Dehli, Melbourne, Mexico City, Mumbai, Sao Paulo, and Seoul) have been investigated. A study by the Institute of Development Studies identified the aspects of urban governance enabling or hindering adaptation to climate change in ten South Asian cities (Bangkok, Chennai, Chittagong, Cochin, Dalian, Da Nang, Hangzhou, Ho Chi Minh City, Ningbo and Surat). Table 1 summarises the main factors affecting the development and implementation of adaptation strategies identified by these studies.

Table 1. Main factors affecting adaptation strategies at the local level identified by previous research.

Factors	Location and focus of the study					
	Six cities in developed countries[2]	Penrith, Australia[3]	UK (Urban Drainage)[4]	UK (NI 188)[5]	Ten cities in the Global South[6]	Ten South Asian cities[7]
Collaboration with external stakeholders	●		●	●	●	●
Strong leadership or championship	●		●	●		
Access to funding	●	●	●			
Awareness within the organisation	●		●	●		
Outsourcing research and other actions	●	●		●		
Sufficient human resources and skills	●	●				●
Public awareness and engagement	●			●		●
Quality / availability of information and data	●	●	●			
Position of adaptation on the list of priorities		●	●		●	
Development of local regulations / policies			●	●		●
Policy frameworks at higher levels			●		●	
Presence of guidance from the State		●	●			
Adaptation actions delivering wider benefits		●		●		
Cross-departmental collaboration	●					●
Long-term perspective	●					
Learning from others						●

It is clear that the studies carried out in the developed and the developing world present similar themes that influence the success of putting adaptation onto the policy agenda. Both collaboration with external stakeholders and internal, cross-departmental collaboration were seen as crucial. The presence of a strong leader or a committed champion of the adaptation agenda, access to financial and human resources, as well as access to, or possibility to develop, a good quality evidence base were also emphasised. Awareness of the adaptation issue among general public and within the organisation were seen as important, as this will influence whether adaptation is perceived as a priority issue. Also the presence of guidance from the State, or existence of a policy framework at

[2] CAP (2007) Cities preparing for Climate Change: A study of six urban regions. The Clean Air Partnership, Toronto. Available at: http://adaptation.nrcan.gc.ca/projdb/pdf/171e_e.pdf

[3] Parsons Brinckerhoff (2009) Climate Change Risk Assessment and Adaptation Action Plan: Volume 1 – Risk assessment Report. Penrith City Council. Parsons Brinckerhoff Australia Pty Limited, Sydney. Available at: http://www.penrithcity.nsw.gov.au/uploadedFiles/Website/Sustainability/Greenhouse/Risk%20Assessment%20Report%20-%20Final%20Sep09.pdf

[4] CIWEM (2007) A CIWEM – CMS conference. Integrated Urban Drainage – Making it happen. May 9th 2007, London, UK. Chartered Institution of Water and Environmental Management. Available at: www.ciwem.org/events/IUD_2007_programme.doc

[5] CAG (2009) Adapting to Climate Change: Local areas' action. CAG consultants, London. Available at: http://www.cagconsultants.co.uk/resources/climate-change-case-study/Adapting_to_Climate_Change_Local_Areas_Action_June09.pdf

[6] Bulkeley, H., Schroeder, H., Janda, K., Zhao, J., Armstrong, A., Yi Chu, S. and Ghosh, S. 2009. Cities and Climate Change: The role of institutions, governance and urban planning. Report prepared for the World Bank Urban Symposium on Climate Change. Available at: http://www.urs2009.net/docs/papers/Bulkeley.pdf

[7] Tanner, T., Mitchell, T., Polack, E. and Guenther, B. (2009) Urban Governance for adaptation: assessing climate change resilience in ten Asian cities. Institute of Development Studies. Available at: http://www.preventionweb.net/files/7849_Wp31520web1.pdf

a national or regional scale to guide the actions of the local authority was highlighted. On the other hand, the autonomy of the local authority in developing local policies and regulations was other important factor influencing the potential success of actions aiming at adaptation to climate change impacts.

2.2 Perceptions of GRaBS partner organisations

As part of the GRaBS project, the partner organisations were asked to identify the strengths, weaknesses, opportunities and threats (SWOT analysis) that they face in delivering green and blue space adaptation responses within their jurisdiction area. The eleven partners that carried out SWOT analyses were:

- Municipality of Kalamaria, Greece
- Regional Environment Centre for Eastern Europe, Bratislava, Slovakia
- Etnambiente, Metropolitan Area of Catania in Sicily, Italy
- The University of Catania, Metropolitan Area of Catania in Sicily, Italy
- Province of Genoa, Italy
- City of Malmö, Sweden
- Provincial Government of Styria, Austria
- London Borough of Sutton, England
- Southampton City Council, England
- Northwest Regional Development Agency, England
- The Amsterdam City District of Nieuw-West (previously City District of Geuzenveld-Slotemeer), The Netherlands.

Linking to the results of the analysis of previous research (section 2.1), one of the most important factors identified as affecting the development of adaptations strategies was the character of existing regulations at the local level (their strength and focus), and the opportunities that local organisations have to revise and update existing regulations (Table 2). Access to knowledge, data and information was perceived as fundamental. Both internal and external collaboration were also emphasised as significant factors, as was the extent of public engagement on adaptation issues. Existing higher-level policy frameworks (including European Union policies) were seen as offering opportunities aiding the development and implementation of adaptation responses at the local level. Financial issues and a lack of leadership hindered the adaptation efforts of the partner organisations. However, their existing human resources and participation in various networks and projects offered an opportunity to increase focus their organisation's focus on adaptation. It was established that limited awareness of the need for adaptation, within and outside the organisation, resulted in the low priority of adaptation on the policy agenda which therefore constrains the development of adaptation responses.

The focus of the analysis on green and blue space responses resulted in the identification of additional factors influencing the development of related adaptation strategies. The quality and quantity of the green space resource currently present in a given location was seen as significant. While the current emphasis on sustainability and contribution of green spaces to the attractiveness of cities and to the quality of life could be used as additional leverage for adaptation responses, the need for urban development and regeneration, often associated with the administrative and socio-economic situation of the area, was seen as a conflicting issue. This could ultimately threaten the development and implementation of adaptation responses.

At the beginning of the GRaBS project, the partners were asked about the type of adaptation responses they would like to see explored during the project. Table 3 indicates the climate change impacts and adaptation response types that the partners were interested in learning more about. It was established that in particular, the partners wanted to learn about solutions to high temperatures and flooding. In terms of adaptation responses, there was interest in operational measures (e.g. internal changes in the organisation and setting up climate change adaptation

partnerships with other stakeholders and the community) and policy measures. Given the scope of partners engaged within the GRaBS project, these issues and concerns are likely to be reflective of the situation in many other local and regional authorities across Europe.

Table 2. Factors affecting development of 'adaptation action plans' focusing on green and blue space measures as identified by the GRaBS project partners

Factor	Internal		External	
	Strength	Weakness	Opportunity	Threat
Regulations and policies at the local level	●●	●●	●	●
Access to and quality of data and information	●●	●●	●	
Cross-departmental collaboration	●	●●		
Public engagement	●	●		●
Policy framework at higher level (national and regional)			●●●	●
Collaboration with external stakeholders	●●		●	
Access to funding		●		●
Learning from others (networking, research projects)	●		●	
Need for urban development or regeneration				●
Strong leadership or championship		●		
Position of adaptation on the list of priorities				●
Existence of a strong sustainability movement			●●	
Public awareness				●●
Existing green space resource			●	●
Level of human resources and skills	●			
Local political and administrative context				●
EU policy influence			●	
Awareness of adaptation within the organisation		●		
Local socio-economic context				●
Contribution of green spaces to quality of life in the city			●	

●●● Nine or more answers; ●● Six to eight answers; ● Three to five answers

Table 3. Preferences of case studies as indicated by partner organisations

Climate change impact	Number of responses	Response type	Number of responses
High temperature	10	Operational measures	7
Flood risk	8	Policy measures	6
Water resources and quality	5	Communication actions	1
Ground conditions	3	Changes in physical infrastructure	1
Fire risk	1		

3 Case studies

3.1 Categories of case studies

Insights gained from previous research findings (section 2.1), the SWOT analysis undertaken by the GRaBS partners and the specific needs for adaptation information expressed by the GRaBS partner organisations during the project (section 2.2) guided the selection of case studies through the development of an associated list of criteria. The aim of the database is to provide case studies that explore different adaptation response types to various climate change impacts at different spatial scales. The database includes case studies of initiatives driven by different factors, which

are often context dependent. Finally, it presents the main factors of success relating to the case studies. Table 4 highlights the distribution of the 15 case studies against these criteria.

Table 4. Categorisation of case studies according to selection criteria.

Climate change impact	
High temperatures	Basel; Berlin; Chicago; Faenza; Nagoya; NW England; Slovakia; Stuttgart; Toronto
Urban flooding	Berlin; Chicago; Malmö ; Nagoya; NW England; Slovakia; Sutton; Toronto
River flooding	England NW; Sutton; The Netherlands
Sea/lake level rise	The Netherlands; New Orleans ;Toronto
Drought	Nagoya
Storms and hurricanes	New Orleans
Poor air quality	Stuttgart
Ground instability	Seattle
Fires	Dorset
Spatial scale	
Neighbourhood	Malmö
Town or city	Basel; Berlin; Chicago; Faenza; Nagoya; New Orleans; Seattle; Stuttgart; Sutton; Toronto
Sub region	Dorset
Region	NW England
Country	The Netherlands; Slovakia
Type of adaptation action	
Regulations	Basel; Berlin; Dorset; Faenza; Seattle; Stuttgart
Policy or strategy	Nagoya; Sutton
Action plan	New Orleans; NWDA; Toronto
Guidance document	Slovakia
Incentive scheme	Basel; Chicago; Faenza
Educational action	The Netherlands
Design action	Malmö
Themes driving the initiative	
Adaptation to future climate	Chicago; Nagoya; NW England; Sutton; The Netherlands; Toronto
Response to current climate	Chicago; Faenza; Malmö; Nagoya; New Orleans; Seattle; Stuttgart; Sutton; Toronto
Mitigation of climate change	Basel; Chicago; Faenza; Nagoya; NW England
Biodiversity conservation	Basel; Berlin; Dorset ; Nagoya; New Orleans
Quality of life/attractiveness of place	Berlin; Chicago; Faenza; Malmö; Nagoya ; NW England; Sutton
Development need despite climate impacts	Chicago; Faenza; Nagoya; NW England; Seattle; Slovakia; Sutton
Water management	Nagoya
Higher-level policy framework	Nagoya; NW England; Seattle; Sutton
Factors of success	
Prioritising adaptation	Chicago; Nagoya; NW England; Sutton; The Netherlands; Toronto
Leadership / championship	Basel; Chicago; Malmö; NW England
Internal collaboration	Berlin; Nagoya; Seattle; Stuttgart; Sutton; Toronto
External collaboration	Basel; Dorset; Malmö; New Orleans; NW England; Seattle; Sutton; Toronto
Outsourcing research	Basel; NW England; Seattle; Slovakia; Sutton; Toronto
Sound evidence base	Berlin; NW England; Seattle; Stuttgart; Sutton; Toronto
Raising awareness internally	NW England; Toronto; Chicago
Public engagement	Basel; Dorset; Malmö ; Nagoya; Seattle; The Netherlands; Toronto
Innovative funding mechanisms	Basel; Dorset
Cohesive delivery of multiple benefits	Basel; Berlin; Chicago; Faenza; Malmö ; Slovakia

3.2 Structure of case studies

Each case study follows a consistent format and includes the following elements:

- A 'Label' in the form of a summary table presenting how the case study fits into the five criteria included in table 4.
- Summary of the case study.
- Description of key issues which includes:
  - Case study location (characteristics of geography and population; current and future climate).
  - Development of the initiative (key aims; main themes driving the initiative; details of the initiative).
  - Implementing the initiative (mechanisms of implementation; building the evidence base; monitoring and evaluation).
  - Stakeholder engagement (collaboration with key stakeholders; engaging the public; political buy-in).
  - Sources of funding.
- Analytical section.
  - Can it have an impact (a discussion of the potential of the initiative to contribute to climate change adaptation goals).
  - Key messages (critical success factors and lessons learnt).
- Contact information and references.

3.3 In-depth case studies

Toronto: Ahead of the storm – development of the climate change adaptation action plan

Climate change impacts addressed	High temperatures Urban flooding River flooding Lake level rise
Spatial scale	Town or city
Response type	Action Plan
Themes driving the initiative	Adaptation to future climate Response to current climate Mitigation of climate change
Good practice	Prioritising adaptation Internal collaboration External collaboration Outsourcing research Sound evidence base Raising awareness internally Public engagement

Summary

In 2008, the City of Toronto became one of the first cities in Canada to develop a comprehensive climate change adaptation strategy. The document, titled *Ahead of the Storm*, details a number of short and long-term actions to adapt Toronto to projected more frequent and more severe heatwaves and flooding. The Strategy highlights the importance of investment in storm water management and in parks and urban forests. The implementation of the actions in the strategy is still at an early stage, and this case study focuses on the process of developing the strategy by the local authorities in Toronto. This included the formation of an inter-departmental Adaptation Steering Group, raising awareness among staff, development of short and long-term adaptation strategies, extensive public consultation, and inclusion of the adaptive actions in budgets of the relevant departments of the City.

Case study location

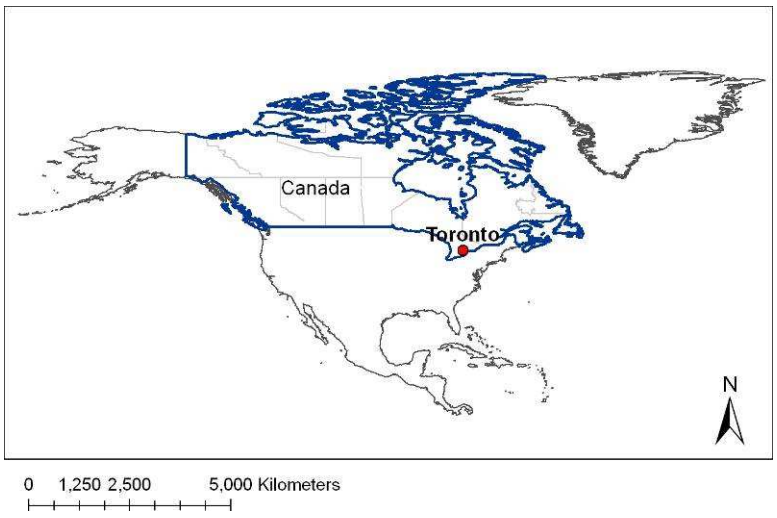

Figure 1. Location of Toronto in Canada.

Toronto is situated on the north-western shore of Lake Ontario, the smallest of North America's Great Lakes. It is Canada's largest city, with approximately 2.7 million inhabitants in an urban region of more than 5 million people. Toronto is the capital of the province of Ontario [(1)].

Toronto has a continental climate with cool winters and hot summers. The climate is moderated by Lake Ontario to the point of Toronto's climate being one of the mildest in Canada. The daily mean temperature for July is 22.1ºC, with the extreme maximum recorded of 40.6ºC (1961-1990) [(2)].

The effects of climate change are already being seen in Toronto. In the last decade, the City has been exposed to extreme heat, floods, drought, new insect pests and new vector-borne diseases [(3)]. In 2005, more than 150mm of rain fell over a three-hour storm in some areas of the city. The storm caused flash flooding, which damaged a major road, flooded over 4200 basements and caused damage to property estimated as up to $500 million (the most expensive storm in Toronto's history). The same summer was the hottest on record: 41 days exceeded the maximum temperature of 30ºC [(4)]. Heat waves currently contribute to an average of 120 deaths per year. The projections for the future include hotter and drier summers (Figure 2). It is predicted that heat-related illnesses and deaths in Toronto will double by 2050s and treble by 2080s if no adaptive actions are taken [(5)].

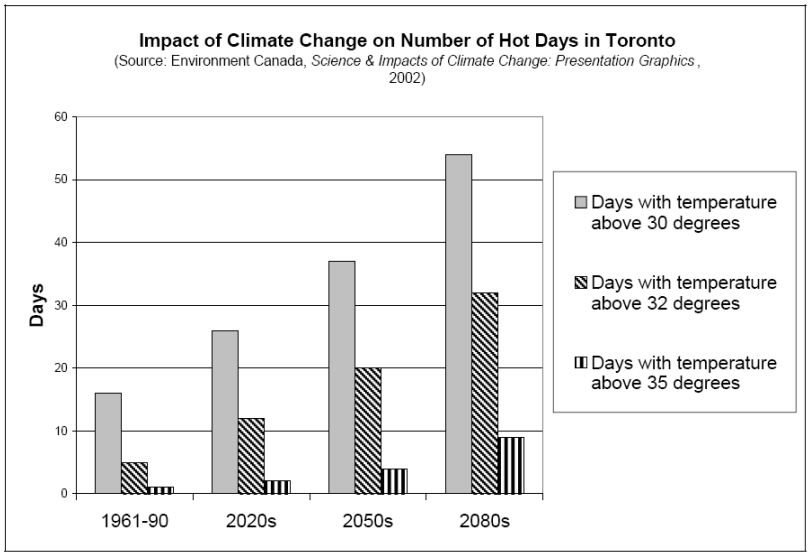

Figure 2. Projected increase in a number of hot days in summer in Toronto [(3)]

Development of the initiative

Key aims

The City of Toronto is one of the first Canadian cities to establish a citywide process to respond to its vulnerability to climate change and develop a climate change adaptation plan - *Ahead of the Storm* (Figure 3) [(4)]. The goals of the document are to:

Figure 3. Title cover of "Ahead of the Storm" [(4)]

- Provide a rationale for incorporating adaptation to climate change into City of Toronto policies, programs and activities, by presenting the current climate, recent changes and future projections;
- Build on existing partnerships to engage the City urban area, including businesses, residents and other stakeholders, in actions aimed at adaptation to climate change;
- Describe programs and actions already underway in the City that provide protection from climate change;
- Suggest short-term actions to increase protection from climate change and provide other benefits to Toronto; and
- Recommend a process to systematically

assess the risks to Toronto of climate change, prioritize areas for action, and develop strategies to reduce the impacts and protect Toronto [3].

The adaptation strategy emphasises actions focusing on use of green and blue spaces, such as increase of tree cover, provision of green roofs, or actions aiming at improved plant health. The strategy lists the necessary actions that need to be undertaken in the short and long term in order to progress adaptation of Toronto to climate change impacts including hotter and drier summers, and more intense precipitation events. It provides recommendations related to the organisational structures of the City Council.

Themes driving the initiative

Need for adaptation

Until recently, the City of Toronto paid greater attention to reducing greenhouse gas emissions than to local climate change impacts and the need for adaptation. This has begun to change as Toronto's weather has become noticeably more extreme. In the last four years, Toronto has experienced the hottest and smoggiest summer in the City's history (2005), the most intense rainfall and costliest flood (also 2005), and one of the driest summers on record (2007) followed by the wettest (2008) [1].

Climate Change Action Plan mandate

The *Climate Change, Clean Air and Sustainable Energy Action Plan* outlining the actions aimed at mitigation of climate change was adopted unanimously by the City Council in July 2007. The Plan also provided a mandate for an adaptation strategy to be developed [6]. Urban green and blue spaces have been identified to simultaneously contribute to mitigation and adaptation to climate change (Figure 4).

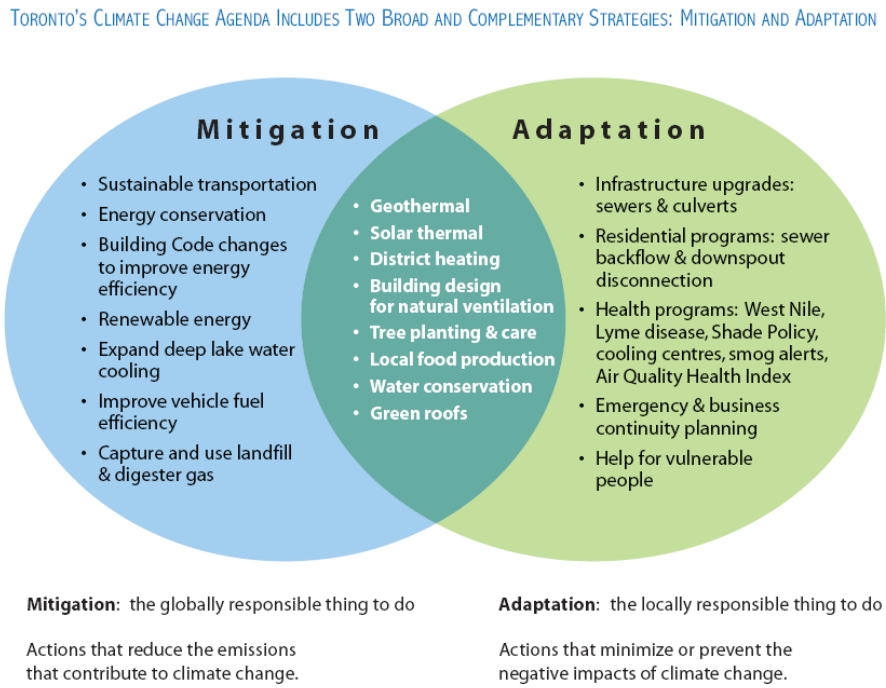

Figure 4. Green spaces as means to both mitigate and adapt to climate change [4]

Existing initiatives aiming at enhancement of green spaces

A number of existing initiatives related to green and blue spaces reinforce their importance in the adaptation strategy [3]:

- Green Roof Pilot Incentive Program, which provides incentives for green roofs to be installed on new or renovated buildings;

- Green Development Standard, which sets performance targets for the design and construction of new developments in Toronto. Amongst other things this aims to reduce stormwater runoff and enhance neighbourhood green space;
- A commitment to double the tree canopy in the City of Toronto to increase shade, reduce the urban heat island effect and reduce runoff;
- Green Parking Lots: draft design guidelines for greening surface parking lots to reduce heat and runoff, prepared by City Planning and pilot projects.

Details of the initiative

Ahead of the Storm proposed a number of short-term actions (for 2008-2009) that could help address current and future climate impacts. Those related to green and blue spaces are as follows [(3)]:

- Live Green Toronto: Direct engagement of communities in greening projects (carried out by Toronto Environment Office and Parks, Forestry and Recreation Department).
- Analysis of when and where green roofs could be required, which will support recommendations for a new Green Roof by-law (City Planning).
- Development of new requirements for the Green Development Standard (City Planning).
- Urban Heat Island research, which aims to identify Toronto's "hotspots", what causes them, and how planning strategies can reduce them (City Planning and Clean Air Partnership).

These adaptation actions were supplemented by activities recommended by individual divisions within the City of Toronto:

- Increase street tree planting (Transportation Services; City Planning; Parks, Forestry and Recreation).
- Expand parkland naturalisation and naturalisation of lands surrounding water and waste water facilities (Parks, Forestry and Recreation; Toronto water; TRCA).
- Increase enforcement of tree protection and planting requirements for private lands during development review, to increase the overall canopy cover (Parks, Forestry and Recreation; City Planning).
- Expand the Integrated Plant Health Care Programme and increase systematic tree pruning services to improve health of plants and trees (Parks, Forestry and Recreation).
- Introduce a new standard for supporting healthy tree growth by continuous soil trench systems in commercial areas. This aims to increase the life of trees from 6 years to 35 years, and consequently increasing shading and cooling (Parks, Forestry and Recreation; City Planning).
- Expand pools, cooling and misting stations to provide summer heat escape locations for City dwellers and residents (Parks, Forestry and Recreation and TRCA).

It was emphasised by the City of Toronto that divisions and agencies that have identified and proposed short term adaptation actions should make the business case for implementing these actions and seek the appropriate approvals to ensure implementation.

However, these short-term actions form only a part of the Strategy, and the emphasis is on development of a comprehensive long-term adaptation strategy. This is to be achieved by completing nine steps. Each of the steps includes several recommended actions [(3)]. A timeline between 2009 and 2011 for carrying out these steps has been developed. The steps are as follows:

Step 1: Create the internal mechanisms and processes for development of a comprehensive adaptation strategy

- Establish a mechanism to secure ongoing **leadership** from City Council and **championship** among senior managers; ensure that the city's leaders are regularly updated about climate change impacts and adaptation planning; make climate change a **key mandate** of the

environment department team and commit to **coordination** of climate change planning across the city's agencies, departments and other units to ensure efficient and effective implementation.
- Ensure appropriate **staff time allocations** in the departments likely to be significantly affected by climate change to assess the impacts and review the adaptation options.
- Develop a **comprehensive funding strategy** for the city's climate change adaptation initiatives.
- Establish a city-wide **Adaptation Steering Group** with a formal mandate, work plan, responsibilities and regular reporting mechanism, including representatives of all sectors that are likely to be affected by climate change.
- Create **issue-based adaptation working groups** in areas that are already experiencing impacts from extreme weather, or at are high risk of impacts.
- Increase the **adaptation capacity of City staff** by awareness-raising activities, engagement in studies on climate change impacts on specific city services and infrastructure, and identification of training needs and opportunities.
- Mobilise **existing expertise**, including the national and regional government agencies and local university researchers, by establishing mechanisms for regular communications and consultations and promotion of the formation of an urban climate change research group to facilitate needed climate change research.
- **Collaborate with adaptation networks and programmes** (regional, national and international), including networks of cities that are developing adaptation strategies, regional initiatives or national associations conducting research and developing guidelines to plan for climate change.

Step 2: Engage the public, business and other stakeholder groups

- **Develop and implement an awareness and engagement strategy**, including: a website with up-to-date information on climate change and its impacts on the city, on the City's strategy, and what residents and businesses could do to protect themselves; public meetings to discuss climate change impacts and proposed adaptation strategies; collaboration with organizations that support vulnerable people in Toronto to make and implement plans that reduce their risks and support for community groups to take adaptive actions.
- **Work with local business leaders and associations** to discuss climate change impacts, strategies and possibilities for long-term cooperation on climate change adaptation.

Step 3: Incorporate climate change adaptation into City policies and high level plans

Particular policies and plans to target should include, for example, spatial plans, green space strategies, emergency response plans, and economic development strategies.

Step 4: Analyze how climate is changing locally and what the future is likely to bring

Undertake research to analyse key historical climate trends in the Toronto region, produce downscaled climate projections and case studies of recent key climate events that provide local climate data and practical information on climate change and its local impacts.

Step 5: Develop a city-wide inventory of climate vulnerabilities and risks

This should include an assessment of vulnerability associated with people's health, infrastructure, physical and natural environment of the city, and the cost to the economy.

Step 6: Conduct a risk assessment to prioritize impacts for action.

This should include assessment of the probability of the impact's occurrence and the severity of impact, and evaluation of the severity of an impact on the physical and natural environment of the city, the health and well-being of Toronto's citizens, and costs to the economy.

Step 7: Identify and assess adaptation options

For high priority risks, identify and evaluate a range of adaptation options that could reduce vulnerability to specific climate change impacts, and that could be implemented in a comprehensive adaptation strategy. Box 1 shows recommended examples or green and blue space adaptation options.

Step 8: Develop and implement detailed climate change adaptation strategies

It was observed that the City will need to **develop clear criteria** for choosing among identified options and developing adaptation strategies. These criteria could include:

- The effectiveness of the adaptation action in protecting vulnerable populations;
- The extent to which proposed adaptation options protect against loss of life or major economic losses;
- Whether the adaptation option reduces stress on vulnerable systems;
- The cost of the adaptive action compared to the cost of alternative strategies, or the potential cost of not acting;
- The extent to which adaptation options also reduce greenhouse gas emissions or provide other benefits that increase the sustainability and liveability of the City.

Also, in creating its adaptation strategy, the City can build on a number of existing programs such as the Heat Alert and Hot Weather Response system and the Wet Weather Flow Master Plan; programmes which are designed to protect the City from the current weather extremes or those aimed primarily at climate change mitigation.

Box 1. Selected green and blue space adaptation options for Toronto [3]

Stormwater and flooding:

- Expand the implementation of sustainable urban drainage systems including permeable pavements, green roofs, stormwater retention ponds, constructed wetlands and swales.
- Create natural eco-system buffers for vulnerable water bodies and low-lying areas.

Energy supply:

- Increase street tree planning and maintenance, green roofs and high-albedo surfaces to reduce urban heat and unsustainable energy demand for air conditioning.

Urban ecosystems:

- Protect existing ecosystems and develop connected greenway system to allow natural species migration.
- Create and preserve green spaces in low-lying areas for flood management.
- Increase shoreline buffers to protect against increased runoff from more intense storms.
- Enhance conditions for street tree survival and growth.
- Monitor and control pests and invasive species that can expand with warmer winters.

Health:

- Interventions to reduce heat island effects including street tree planting, green roofs, high albedo roof and road surfaces.

Step 9: Monitor and measure progress.

Formal mechanism for periodic review of progress on climate change adaptation should be established. The progress of the implementation of the plan should be communicated to decision-makers and the public.

Implementing the initiative

The process started in September 2007, and on July 2008 the Toronto City Council unanimously adopted "Ahead of the Storm", as a climate change adaptation strategy for the City. This builds on existing programs that provide protection from current weather extremes. It includes a commitment to short term actions, as well as a longer term process for developing a comprehensive strategy. Currently, Toronto is at the early stages of implementing the strategy [(1)].

The Toronto Environment Office established a **cross-departmental Adaptation Steering Group**, including representatives of policy and programme staff from 14 City divisions and agencies. The Steering Group is chaired and supported by the Toronto Environment Office and provides updates to the Executive Environment Team [(3)].

Whilst some individuals involved in the process expressed concerns regarding the scientific basis of climate change, additional workload and cost of adopted measures, a strong steer from the Deputy City Manager's office ensured that the group worked together [(1)].

Many members of the Adaptation Steering Group had little experience in assessing climate change impacts and planning to adapt to them. To raise the awareness, the following actions were undertaken [(1)]:

- Compiling information about what other municipalities were doing on the issue;
- Encouraging attendance at workshops and conferences to increase familiarity with concepts and issues relating to climate change impacts and adaptation;
- Participating in the regular webinars of the new Canadian Alliance for Resilient Cities as well as meetings of its U.S. counterpart, the Urban Leaders Adaptation Initiative; and
- Organizing meetings with the Climate Change Scenarios Network, the Public Infrastructure Engineering Vulnerability Committee, the Canadian Institute of Planners, and others to help the City with thinking about climate change scenario modelling, infrastructure risk assessment and other issues.

The group met weekly between September 2007 and April 2008 and jointly prepared a broad adaptation strategy. When the first draft was completed, fourteen City departments made detailed and, in many cases, contradictory recommendations, which had to be considered in reworking the document. The outcomes of the process were included in the framework document (*Ahead of the Storm*) and a summary report for wider distribution, which were subject to public consultations [(1)]. The adoption of the adaptation strategy means that the Council is now committed to:

- Incorporate explicit goals for adaptation of infrastructure and buildings into Toronto's Official Plan (up for review in 2010), which guides all land-use planning and development for the City. This will ensure that climate change impacts are taken into account in all new developments and major redevelopments;
- Incorporate climate change into planning of all City agencies and divisions and identify in the 2009 budget submissions for specific short-term actions;
- Investigate a funding strategy for climate change adaptation;
- Establish a process for the development of a long-term, detailed and comprehensive adaptation Strategy;
- Establish an Urban Climate Change Network to support co-operation, among governments, universities, colleges and non-governmental organizations [(1)].

Building the evidence base

Due to lack of specific information related to climate change projections for the City of Toronto, *Ahead of the Storm* and the actions included in the strategy are not based on climate change data. However, *Ahead of the Storm* recommended a number of short-term actions targeted at increasing knowledge about climate change impacts and adaptation responses. Completion of the study of recent climate trends and future climate projections for the region carried out by the Toronto Environment Office will help to establish specific adaptation targets for the new or expanded programmes produced by the City of Toronto divisions. The information collection actions included:

- Future climate prediction modelling that would improve the information on expected climate extremes and gradual changes to permit better decision-making on adaptation planning;
- Assessments of climate change vulnerability and risk assessment of City operations, to prioritise needs for adaptation actions based on consideration of highest vulnerability and risk;
- Development of regional extreme precipitation intensity, duration and frequency curves to improve ability to design storm drainage infrastructure for extreme runoff events;
- Scan of methods used in other areas for assessing vulnerability of the population to heat [(3)].

Monitoring and evaluation

Monitoring arrangements were not included in the adaptation strategy. However, it was observed that periodic assessment of the progress that Toronto makes in preparing for climate change is necessary. It was recommended that this assessment should focus on the following:

- Level of public, staff and stakeholder awareness about climate change and its impacts and support for actions to protect against climate change;
- Vitality and perseverance of collaboration between the City, its communities, researchers, non-governmental organizations and other levels of government on addressing climate change issues;
- Technical capacity to assess the risks of climate change;
- The extent to which climate change considerations have been incorporated into high level policies, plans and practical programs in priority impact areas;
- The extent to which climate change adaptation strategies reduce stress on vulnerable systems;
- The effectiveness of implemented adaptation strategies in extreme weather events.

Sources of funding

In January 2009, the City created an Environmental Protection Reserve Fund for the purpose of funding the development of Toronto's long-term adaptation strategy, the operating budget for the Toronto Environment Office and Energy Efficiency Office, and for projects such as Deep Lake Water cooling and expanding the tree canopy. For 2009, the City committed $500,000 from this fund for the climate and risk assessment studies.

The Parks, Forestry and Recreation Division successfully appealed to the City for extra funds to expand the maintenance of existing trees, increase tree planting and to support research into effective ways of improving the health and growth of urban trees and increasing the tree canopy.

The Toronto Environment Office budgeted funds in 2008 for predictive computer modelling of the Toronto area's climate, which will provide decision makers with better information on future severe weather scenarios. Budget was also available in 2008 to obtain expert assistance in vulnerability and risk assessment. Additional funds may be necessary in the future to identify the costs and benefits of effective adaptation strategies, and other investigative tasks recommended in this report. Funds will also be needed for expanding activities and programs that reduce the impacts of extreme weather such as heat waves, intense rainfall and droughts [(3)].

Stakeholder engagement

Collaboration with key stakeholders

The Clean Air Partnership (CAP), a local non-governmental organisation, played a crucial role in emphasising the need for including adaptation in climate change action plans produced by the Council. CAP had published *A Scan of Climate Change Impacts on Toronto* in 2006, and met individually with the Mayor and many City Councillors to discuss the need to adapt to avoid the worst impacts. CAP also hosted two workshops for City of Toronto staff on the issue. As a consequence, the City incorporated a commitment to investigate Toronto's vulnerability to climate change in *Change is in the Air* [8], the City's climate change plan.

Working with stakeholders was crucial to developing the adaptation action plan. The following stakeholder collaboration was undertaken by the CAP:

- Established an Expert Panel of leading local scientists and policy thinkers to obtain ideas from experts on the topic of climate change adaptation. The first meeting was primarily for City staff, and the second was convened at a Special Meeting of the Parks and Environment Committee in January 2008. Over 150 people attended this public event [7].
- Met with Environment Canada, Institute for Catastrophic Loss Reduction, Engineers Canada, Canadian Institute of Planners to learn about climate change scenarios, infrastructure risk assessment, integrating adaptation into spatial planning and other issues;
- Joined the Alliance for Resilient Cities network of Canadian cities & the U.S. Urban Leaders Adaptation Initiative to exchange information & ideas with peers in other cities;
- Held internal meetings with key City divisions to discuss expected impacts on their operations, describe what other cities are doing, and initiate discussions about adaptation planning;
- Hosted internal & public events to present and discuss issues and plans with political officials, staff, the public and the media [1]
- The Environment Office set up the Toronto Urban Climate Change Network (TUCCN; http://www.tuccn.org/index.php) to support co-operation, among governments, universities, colleges and non-governmental organizations on climate change mitigation and adaptation actions and strategies relevant to the City of Toronto and other urban centres. One of the first activities of the Network was to organize the *Forum on Infrastructure and Climate Change Adaptation* in April 2009, designed to promote the integration of climate change considerations into urban infrastructure projects. A large number of City staff attended this forum and participated actively in its discussions and deliberations.

Engaging the public

The Toronto Environment Office held six meetings to consult the public and stakeholders on *Ahead of the Storm*. Each of the meetings began with a presentation of the main issues and recommendations from the document. Attendees were then invited to discuss the impacts they felt were key, any gaps they saw in the City's analysis and action the City should take.

Many of the participants at the consultation meetings struggled with the concept of climate change adaptation. They were much more familiar with – and many were more committed to – mitigation measures to reduce greenhouse gas emissions than adaptation. Business representatives were quick to understand some of the potential impacts of climate change, since several had experienced the adverse economic effects of power outages, floods and other results of extreme weather. As a result, business groups had a strong focus on emergency response issues. All the meetings recommended that the City should increase and broaden education programs to make Torontonians aware of the threats of climate change, and about potential adaptation solutions [1].

The public was invited to comment on the Strategy via scheduled public meetings (details provided on the City of Toronto website); submitting written comments by email and mail; calling the 24-

hour comment line for the City of Toronto Climate Change Adaptation project; or providing a personal input to the Parks and Environment Committee on a given date [4].

Capacity building in the community is one of the main action streams in the adaptation strategy. This includes development and implementation of a further public and stakeholder engagement strategy, including creating a website outlining the climate change impacts and adaptation, organising public meetings to discuss adaptation strategies as they develop, and support community and neighbourhood groups taking adaptation actions through Live Green Toronto website (http://www.toronto.ca/livegreen/index.htm). Work will be undertaken to collaborate with organisations that support vulnerable populations in Toronto to make and implement plans that reduce their risks to climate impacts, and with local business leaders and associations to discuss climate impacts, strategies and possibilities for long-term cooperation on climate change adaptation.

Political buy-in

Following the public consultations the Toronto Environment Office prepared a Staff Report on a *Climate Change Adaptation Strategy* with recommendations for Council [7]. The report was adopted unanimously by Council on July 15, 2008.

Can it have an impact?

The City has shown considerable leadership in acknowledging the need for adaptation and taking early action. Also, there are existing projects and initiatives that have the potential to provide a springboard for future adaptation responses. However, this array of current projects and activities is not yet welded together into a detailed long-term strategy, and there are both internal and external barriers to the development and implementation of such a strategy. These barriers include [1]:

- **Uncertainty about future climate change and impacts.** It is hard to get decision-makers to commit to what could be expensive and long-term adaptation projects and retrofits when they are not yet convinced about the extent and the timeline of expected changes to the climate. This will be addressed by the two research projects on future climate impacts commissioned by the Toronto Environment Office.
- **Limited staff and lack of organisational structures.** While the City has dozens of staff working on projects and programs related to climate change mitigation, there is only one staff member whose primary work is adaptation [3]. Toronto's Adaptation Steering Group worked as an ad hoc group without a clear mandate, targets, or regular meeting schedule. Activity by the group as a whole diminished after City Council adopted the Climate Change Adaptation Strategy, at a time when the hard work of implementing an integrated strategy needed sustained attention.
- **Financial resources.** Toronto has a major infrastructure deficit stemming from cutbacks in spending by governments at all levels during the previous two decades. While the need to replace infrastructure may be regarded as an opportunity for incorporating adaptation options, existing funding is inadequate: either lacking or requiring quick solutions to problems, which is likely to reduce the integration of climate change adaptation measures in the projects.

Despite these challenges, it is important to recognize the leadership that Toronto has shown as one of the first urban centres in Canada to acknowledge the need for climate change adaptation and to take substantive action to tackle the problem. Toronto has made significant headway in the development and implementation of climate change adaptation plans and activities. It will be important for the City to maintain focus and momentum in order to weld together a coordinated and comprehensive strategy out of the array of activities on which it has embarked, to protect its citizens from the impacts of climate change [1].

Key messages

- Setting up an inter-departmental Adaptation Steering Group was crucial to the success of the project.
- Involvement of staff in seminars, conferences, and other events was a successful strategy to raise awareness and gain acceptance for the project.
- Cross-cutting character of climate change adaptation was captured in the requirement for all the relevant departments to include climate change adaptation in their actions.
- The requirement for divisions to specifically address mitigation and adaptation in their budget submissions is a major step forward in mainstreaming adaptation thinking and action.
- Adaptation in Toronto will require continued engagement, institutional commitment, creative thinking, and funding [(1)].

Contact organisation

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The Netherlands Live with Water: Public awareness raising campaign

Climate change impacts addressed	River flooding Sea level rise
Spatial scale	Country
Response type	Educational action
Themes driving the initiative	Adaptation to future climate
Good practice	Public engagement

Summary

The climate change projections for the Netherlands project an increased risk of coastal and river flooding. It was acknowledged in 2000 that the current water management system based on technological solutions is inadequate, and that more space needs to be made for water. It was also recognised that citizens do not sufficiently recognise and acknowledge the potential problems associated with water. Consequently, in 2003 "The Netherlands Live with Water" public awareness campaign was launched (Figure 1). The campaign emphasises the need to store water along both the main national and regional water management systems during times of excessive rainfall or high levels of river discharge. It also promotes the actions that individuals can do themselves to help reduce the threat of flooding. The campaign has used the Netherlands favourite weather presenter as their spokesman. Independent reviewers have assessed the campaign as being an effective awareness raising approach.

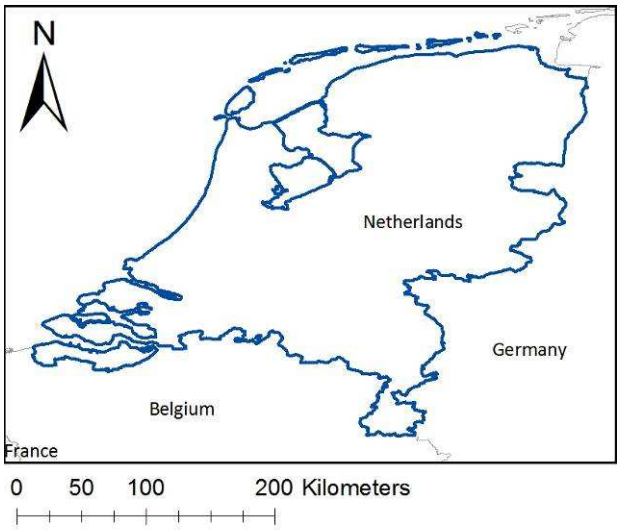
Figure 1. "The Netherlands Live with Water" campaign logo

Case study location

The Netherlands covers 41526km^2 and is home to 16.5 million people. The country is located on the North Sea, and is dominated by mouths of four great rivers: Rhine, Meuses, Wall and Scheldt. The majority of the country is located below sea level (Figure 2) and the history of the Netherlands has been dominated by the fight with water and reclaiming land from the see, which was first documented in 1533. The Netherlands is protected from coastal and riverine flooding by 3,500km of primary flood defences. These are accompanied by 14,000km of dikes around basins, polders and canals, reducing the risk of flooding from smaller water bodies and watercourses. An extensive and complex system of ditches and waterways serves to manage the groundwater level in these polders. Every drop of rain that falls in the polders must be pumped out. Consequently, every polder is connected to a pumping station that transports the water to a drainage outlet or pool. From there, it is pumped out to the other waterways and, finally, flows to the sea. The flood defences are mainly managed by the water boards [(1)].

One of the most spectacular engineering achievements in the Netherlands is the Delta works which involves construction of flood barriers, many kilometres of dike reinforcements and the closure of a number of sea arms. This was done to protect the province of Zeeland from flooding after the

disastrous floods in 1953, which claimed lives of 1,800 people, involved the evacuation of 72,000 and flooded about 2,000km^2 of land [(1)].



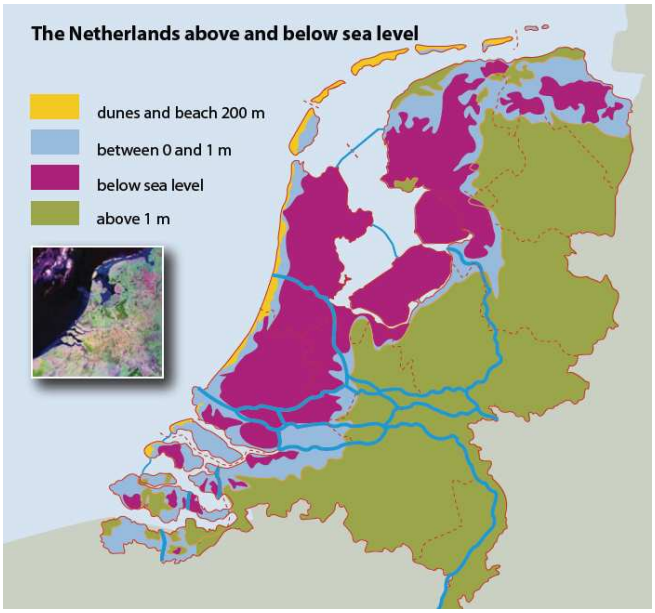


Figure 2. Location of the Netherlands and elevation of the country [(5)]

The Royal Netherlands Meteorological Institute (KNMI) provides climate change scenarios for the Netherlands. Temperature is projected to rise and mild winters and hot summers will become more common. On average, winters are projected to become wetter with extreme precipitation events increasing. Mean precipitation for 2050 in winter could increase by between 3.6 and 14.2%, while precipitation on a wet day is likely to increase by between 3.6-12.1% compared to 1990 values [(2)]. Climate change has the potential to lead to a 40% increase in river discharges in winter and 30% lower discharges in summer [(3)].

Figure 3. Flooding threat in the Netherlands

According to measurements in coastal areas and with sea-based buoys, the sea level has risen by 1 to 2 mm per year since 1900, amounting to a 20cm increase over the last century. Sea level change projections span a range between 15 and 35cm by 2050, and between 35 and 85cm for 2100, compared to 1990 values. The extent of sea level rise will depend on future carbon emissions and the speed of melting of terrestrial ice masses. At the same time, the Netherlands is subsiding between 0-4mm a year [(2)] due to oxidation of peat, soils subsidence and that sand and clay deposits are no longer being replenished by floods. In the low-lying parts of the Netherlands, soil subsidence will average between 2 and 60cm by 2050 [(3)]. As a result of these factors, river flooding and coastal flooding are likely to become more common (Figure 3).

Development of the initiative

Key aims

The aims of "The Netherlands Live with Water" campaign are:

- To increase the awareness of the water problem, stimulating a sense of urgency without frightening the people;
- To communicate that a new approach and policy for water management is needed and also the reasons why;
- To increase knowledge of what this new policy ('giving more room to water') means and what the consequences will be;
- To get acceptance of the idea that far-reaching measures are needed now to keep Holland safe in the future, even if these measures have unpleasant personal consequences [(4)].

Themes driving the initiative

Adaptation to climate change was one of the main drivers behind this initiative. Climate change, combined with the growing population density and growing value of the national economy, increases the consequences of potential flooding events [(3)]. The risk of flooding, which has been a significant public issue since the flood of 1953, was highlighted during the floods in 1993 and 1995 in the Maas (Meuse) and Rhine valleys.

For centuries, spatial planning in the low-lying Netherlands has been a matter of separating and maintaining the division between land and water. However, in 1999 the Ministry of Transport, Public Works and Water Management and the Association of Water Boards formed an independent Committee to assess whether the current water management policies were adequate to deal with the effects of climate change and to maintain a safe, liveable and attractive environment [(3)].

The Committee in its 'Water Management Policy in the 21st Century' report stated that a change in water management policy was required, involving relinquishing space to water rather than winning space from it [(3)]. This was to be achieved by lowering the flood plains, widening the flood plains by moving dikes further back from the river and construction of water retention and storage areas. The measures taken have enabled the development of a long-term strategy for the safe removal of 18,000 m^3/s in the River Rhine at Lobith [(1)]. The new approach may appear simple, but it isn't, even if only because the costs are so high, and the fact that the costs are to be born by society. A key challenge is therefore to create sufficient support for the initiative within society [(5)].

It was found that individuals and social interest groups do not sufficiently recognise and acknowledge the problems associated with water. This is due to low awareness and trust in technology. Therefore, the Government made the decision to launch a public awareness campaign to better inform individuals and social interest groups about the risks and opportunities of living in a river delta area, and to encourage support for actions aimed at "making room for water" [(1)]. While the major defensive works were, up till the end of last century, built and paid for by the government. However, the current adaptive management responses are a shared responsibility between all levels of government, the private sector, non-governmental organisations and civil society at large. Such an approach therefore requires strong public support, and communication is a key feature of the new strategy [(5)].

Details of the initiative

The Netherlands Live with Water campaign is one of three major communication campaigns related to raising awareness of the risk of flooding. The other two are "Denk vooruit" (Think ahead) and a collection of risk maps on the Internet [(7)].

Figure 4. Cartoon featuring Peter Timofeeff, a TV weather forecast presenter. The text reads: "With the climate change it gets warmer and wetter".

The Netherlands Live with Water campaign uses a combination of a range of mass media approaches. The campaign uses radio and television commercials, newsletters, advertising and information booklets, informative events and a comprehensive website. A study of a representative sample of 277 people indicated that 86% of people look for information about changes in climate on Internet; 53% on TV; 43% in daily papers; 27% in magazines [(6)]. There is a website where responsible parties in the public authorities can download material [(7)]. A well known presenter of weather forecasts, Peter Timofeeff, is used as a spokesman for the campaign and is a "Water Ambassador". On national and regional radio and television, he brings the problems and solutions to peoples' attention through cartoons and personal appearances [(1)]. The campaign contains humorous elements to draw the attention of the public [(4)] (Figures 4 and 5).

Implementing the initiative

The campaign started in 2003 and is ongoing. Initially, the campaign focused around the message that the climate is changing and that this has consequences for water management in the Netherlands. Gradually, the campaign has put in simple terms what measures such as storing water mean in practice. Moreover, it highlights the efforts the national government, provincial authorities and water boards are undertaking across the Netherlands to keep the country safe and dry [(1)]. In the future, the campaign will emphasise the concrete measures and examples of adaptation that are recognisable to the public and provide inspiration for administrators [(5)].

Monitoring and evaluation

The effectiveness of the campaign is monitored though a continuous survey carried out by TNS NIPO market research company. The monitoring and evaluation approach focused on the reach, impact, appreciation and comprehension of the campaign by the public. For measuring the actual reach of the campaign, recognition if the website, TV and radio commercials and the print advertisements is measured. The publics' engagement with the campaign is measured through assessing factors such as whether it is credible, informative, clear, funny, irritating etc. Comprehension is measured through a series of open questions. This information gives a good picture of the strengths and weaknesses of the communication approach [(4)]. The monitoring of the effectiveness of the campaign has resulted in adjusting the media used, i.e. using more print media rather than TV advertisements to reach a wider range of people [(4)].

Sources of funding

The campaign is funded by the central government. The key funding need was the media budget for advertising. It was €1.3 million. Half of the money was spent on TV commercials, 25% on print media; 20% on outdoor media (e.g. billboards), and 5% on radio [(4)].

Figure 5. Cartoon featuring Peter Timofeeff, a TV weather forecast presenter.

Stakeholder engagement

The lead authority responsible for the development and implementation of the initiative was the Ministry of Transport, Public Works and Water Management. Other organisations involved include Association of the Provinces of the Netherlands, Association of Dutch Water Boards, Association of Netherlands Municipalities, Ministry of Public Health, Spatial Planning and Environment, and Ministry of Agriculture, Nature and Food Quality [(5)].

Alongside the general public there are four key groups that are especially targeted by the campaign:

- Residents of areas in which water is a known problem or is especially relevant.
- Residents of cities.
- Homeowners.
- Businesspeople (e.g. farmers and gardeners).

Also, the campaign involves educational action for individuals working in the public administration and educational sectors [5].

Can it have an impact?

The public believe that the campaign has to date been informative and believable [1]. The awareness-raising part of the campaign seems to have worked, as most Dutch are now aware that more water is coming into Holland [4]. Rising sea levels and river flooding are now seen as important concerns [6]. The awareness that the government is implementing measures to balance the effects of climate change has also increased significantly. The main philosophy of the new policy approach: giving more room to water, has been increasingly accepted by the public over the course of the initial campaign period [4]. At the end of 2003, 82% of the population recognised the social importance of measures to protect against flooding, and 72% endorsed the proposition that this would have to involve 'giving water more room' [1]. In 2009, 55% of a representative sample of the public were in favour of introducing a "water square" near their development to contain excess rainwater. However, three-quarters of the respondents were in favour of large-scale structural solution to sea flooding, i.e. the Delta Dyke, suggesting that the belief in technological defences is very strong [6].

Weatherman and 'Water Ambassador' Peter Timofeeff is seen as an appealing and likeable expert [1]. However, the campaign is focused on risk communication rather than disaster communications. Consequently, the concrete actions communicated that individuals can take to help respond to the problem are rather limited [7]. Furthermore, risk communication seems to be a taboo in terms of publicly speaking of a flood disaster as a realistic scenario that the Netherland's could face. The resulting lack of clarity on the issue obstructs the Dutch government in bridging the gap in perception between itself and society in order to achieve its policy objectives [8].

"The Netherlands Lives with Water" campaign has achieved good results. The Dutch government will nevertheless have to now concentrate even more on communicating the effects, risks, and opportunities of climate change, and the measures needed to adapt to it. Where water is concerned, this means following the path which has already embarked on which involves communicating the risks, opportunities, possible future actions, available knowledge, available tools, etc that are available to address the problem. A long-term communication strategy will involve engaging all relevant stakeholders with the necessary adaptation measures through an open dialogue. The goal is to ensure active co-operation, in which all stakeholders accept their own responsibility in addressing problems relating to water in the Netherlands [5]. In the 2006 annual report of the campaign [9] regional level communication is recommended as being especially important. It is also particularly important to communicate relevant issues in as explicit a manner as possible for residents [7].

Key messages

- To make significant changes in land use aiming at climate change adaptation, public needs to be well informed. This helps to avoid protests and ensures better cooperation in the implementation of strategies.

- The use of a variety of communications channels (TV commercials, newspaper cartoons, and a website) ensures that the message reaches different audiences and different sections of the public.

- The use of a popular, likeable expert as a spokesman is one of the key elements that supported the success of the campaign

- Monitoring of the effectiveness of the public campaign allowed significant changes to be made to improve the approach taken.

- A significant obstacle is the "taboo" character of risk communication relating to future flood risk. This was overcome by the use of likeable expert. However, that may have also resulted in diluting the message.

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Stuttgart: Combating heat island and poor air quality with green aeration corridors

Climate change impacts addressed	Poor air quality High temperatures
Spatial scale	Town or city
Response type	Regulations
Themes driving the initiative	Response to current climate Adaptation to future climate
Factors of success	Internal collaboration Sound evidence base

Summary

Stuttgart's location in a valley basin, its mild climate, low winds and surrounding industrial activity has made it susceptible to poor air quality since the 1970s. Development on the valley slopes have made the situation worse by preventing air from moving through the city, which contributes to the urban heat island effect. Consequently, Stuttgart has been planned to exploit the role of natural wind patterns and dense vegetation in reducing problems of overheating and air pollution. A Climate Atlas was developed for the Stuttgart region, presenting the distribution of temperature and cold air flows according to the city's topography and land use. Based on this information, a number of planning and zoning regulations are recommended which aim to preserve open space and increase the presence of vegetation in densely built-up areas. The planning recommendations build on the legislative framework of the German Building Code and other national, regional and locally developed regulations.

Case study location

Stuttgart is the capital of the German Land (federal state) of Baden-Würtemburg and has a population of approximately 600,000 (Figure 1). The city is located in the centre of an industrial region that is home to more than two million and is well-known for its high-tech industry [(1)].

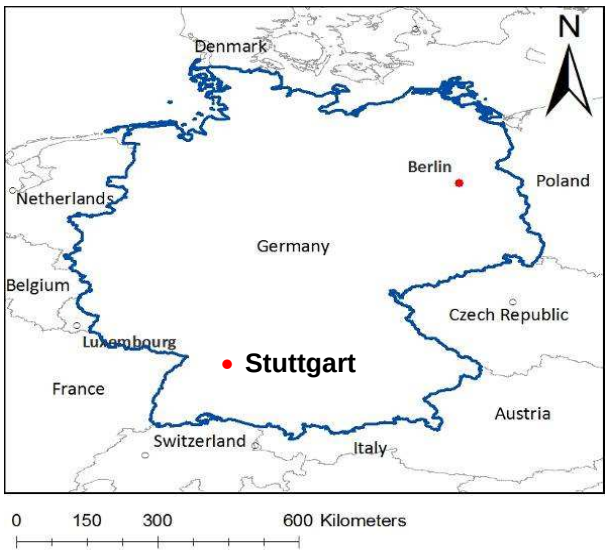

Figure 1. Location of Stuttgart in Germany

The city's location has a significant influence on its local climate with variables including radiation, temperature, humidity, precipitation and wind affected. Stuttgart sits in the wide Neckar basin formed by two river valleys, shielded by the steep hill slopes: Black Forest in the West, the Swabian Alb in the South, the Schurwald in the East and the Stromberg and Heuchelberg region in the Northwest. Stuttgart's centre is located at about 240m above sea level, while the surrounding hills reaching up to 500m a.s.l. The only opening to the Neckar Valley is in the Northeast along the Nesenbach valley, which narrows towards the southwest (Figure 2) [(2)].

Stuttgart has a mild, temperate climate with warm summers that are moderate enough to allow wine production on valley slopes. The mean summer temperature is 18ºC, mean winter temperature -1ºC. Wind speeds are generally low, which along with the urban heat island effect, contributes to

poor air quality. Stuttgart's climate is mostly affected by altitude; the urban core can have winters with no snow, while the surrounding hills can have up to 54 days of coverage (Figure 3) [(1)].

The future climate projections for 2071-2100 suggest a 2ºC increase of mean annual temperature [(3)]. The projections for heat waves are based on the assumption that the number of days with heat stress (when people's thermoregulation is impaired) will increase significantly. By 2100, 57% of the Greater Stuttgart region could have more than 30 days with heat stress (in the low lying areas even over 60 days) [(3)]. Therefore, a significantly higher percentage of people will be exposed to heat waves than at present [(4)].

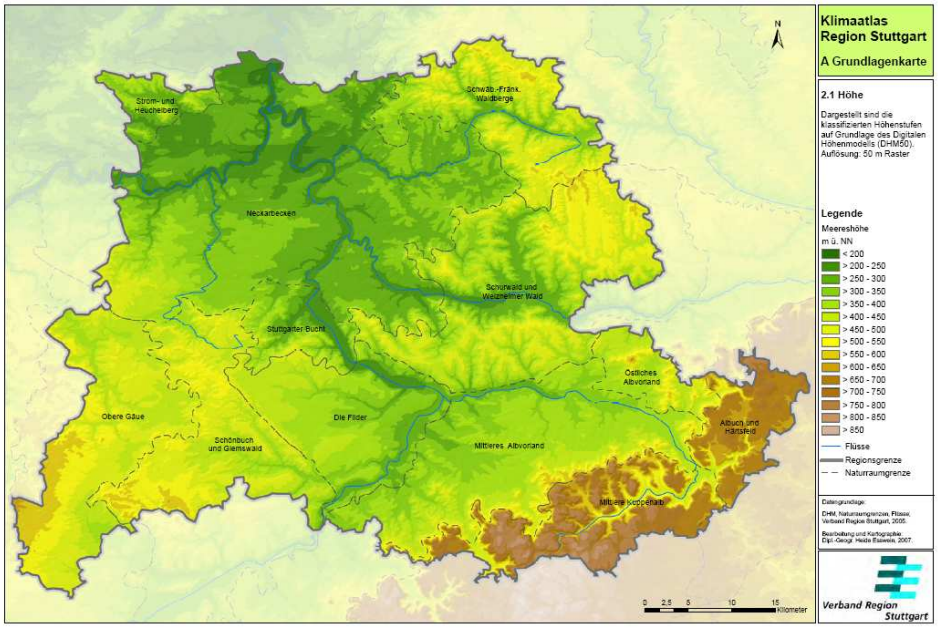

Figure 2. Topography of Stuttgart – green colours indicate lower locations, yellow and brown - higher [(3)]

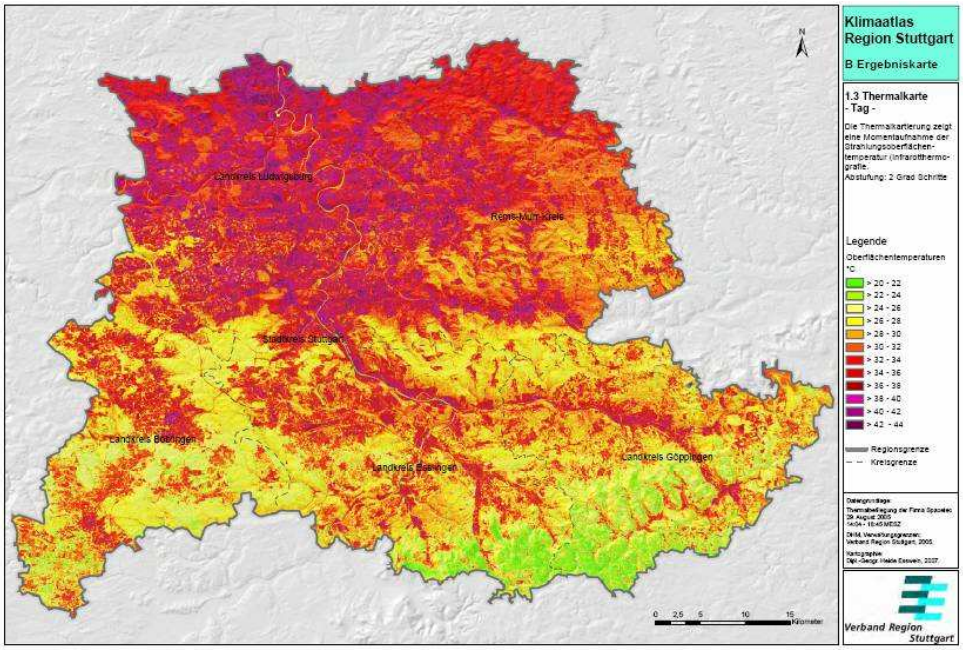

Figure 3. Day surface temperatures corresponding with the topography of the city: purple and red – high temperatures; green - low [(3)]

Development of the initiative

Key aims

The primary objective of the planning recommendations informed by the Climate Atlas 2008 for the region of Stuttgart is to facilitate air exchange in the city and enhance cool air flow from the hills towards the urban areas on the valley floor. This is to be achieved by specific measures aimed at the maintenance and enhancement of open spaces and provision of vegetation. The measures are targeted at locations that have an important role in air movement and air exchange across Stuttgart. In general, no development is allowed that would obstruct air-flow in key strategic areas, felling of trees over a certain size is banned, and green roofs, green facades and other solutions are promoted in densely developed areas.

Themes driving the initiative

History of research urban climatology
The importance of climatic conditions for human comfort in health has been recognised in Stuttgart since 1938, when the city council employed a meteorologist whose job was to analyse the climatic conditions in Stuttgart to understand the connection between climate and urban development [(5)]. In 1992 the first Climate Atlas was developed illustrating how landforms and structures affect the movement of air through the city, and identified the surrounding slopes, forests and agricultural areas as major sources of fresh air for the city. It was found that the air pollution problem resulted from increased urban growth onto valley slopes, which replaced vineyards and trees with built form [(1)], which was blocking the flow of fresh air into the city. These findings had a significant impact on city planning. The city established the Environmental Office which was given the task of assessing proposed developments and their effect on the local climate. The aim was to preserve the areas key to the improvement of the local climate by development control measures, and to improve the presence of vegetation across the city [(1)].

National and Land-level legislation:
The preservation of natural environment in urban areas is principally guided by the Federal Nature Conservation Act (BNatSchG) and by the Nature Conservation Act of the Land of Baden-Württemberg (NatSchG). The Federal Nature Conservation Act prohibits the modification or impairment of protected green spaces, or changing land use in these protected areas. Protected green spaces comprise: green zones in settlement areas, parks, cemeteries, significant gardens, single trees, lines of trees, avenues or groves in settled or unbuilt areas; and some plantings and protective wood outside forests. Preserving the history and culture of the region can also be a reason for protecting of green spaces.

German Building Code (Baugesetsbuch, or BauGB) from 1960 is an important influence over urban development. The regulations were revised in 2004, and now require precautionary environmental protection in urban zoning and planning practices. § 1 (5) states that urban development planning has to be sustainable, integrating social, economic and ecological demands, and also assuming responsibility for future generations. Urban development plans must contribute to the creation of an environment that is fit for human beings, that protects natural resources, that contributes to climate protection, as well as preserving and developing the urban pattern and appearance of the landscape of towns and cities. According to § 1 (6) the following aspects have to be taken into account (amongst others) when establishing urban development plans: the presentation of landscape plans and green open space structure plans, as well as other plans concerning issues such as water rights, waste rights and pollution control rights; and the conservation of the best possible air quality [(6)].

Details of the initiative

The Climate Atlas

In 1987, the Section of Urban Climatology within the Office for Environmental Protection of the City of Stuttgart was tasked with a technical reworking of a climate analysis for the neighbourhood association of Stuttgart. An accompanying task force on "Climate" was established within the neighbourhood association of Stuttgart, whose job was to coordinate the scope, form and contents of the planned Climate Atlas. The purpose of the Atlas was to make available the basic materials required for a proper consideration of all climatic and air-related issues in Stuttgart during planning processes undertaken by the association and its participating towns and municipalities [(7)].

In 2008, the new Climate Atlas for the region of Stuttgart was published [(3)]. It covers the whole area of the region (3654 km²) and provides standardised climatic evaluations for all 179 towns and municipalities in the region and its 2.67 millions of inhabitants [(4)]. The Atlas comprises maps at scales of 1:100,000 and 1:20,000 (see Figures 2 and 3), which show regional wind patterns, flows of cold air, air pollution concentrations, and much other relevant information required to inform planners on what to do for urban climatic optimization in new projects and retrofits (Figure 4 and 5). The Climate Atlas provides technical support for decision making regarding land use planning.

The determination of the current climatic situation allows for the assessment of possible changes and significant effects of planning and development decisions on climatic variables. A key element of the Atlas is an area classification based on the role that different locations play in air exchange and cool air flow in the Stuttgart region. This is defined topography, development density and character, and provision of green space. The Atlas distinguishes eight categories of areas in this manner, and for each of them different planning measures and recommendations are provided (Table 1 and Figure 6) [(4)].

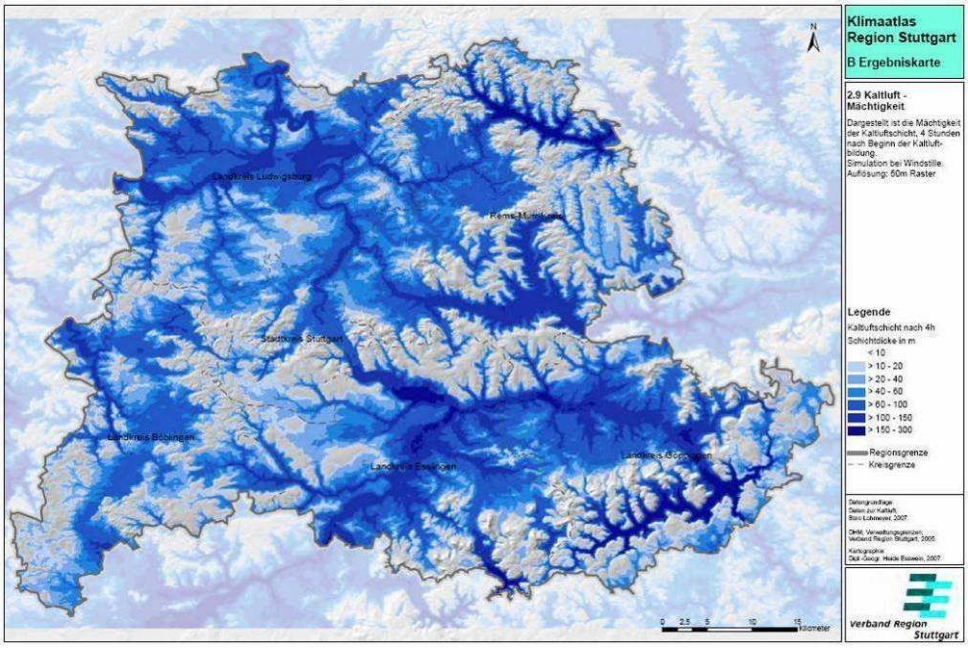

Figure 4. Intensity of cold air layers four hours after the beginning of cold air movement. The darker the blue, the thicker the layer of cold air [(3)]

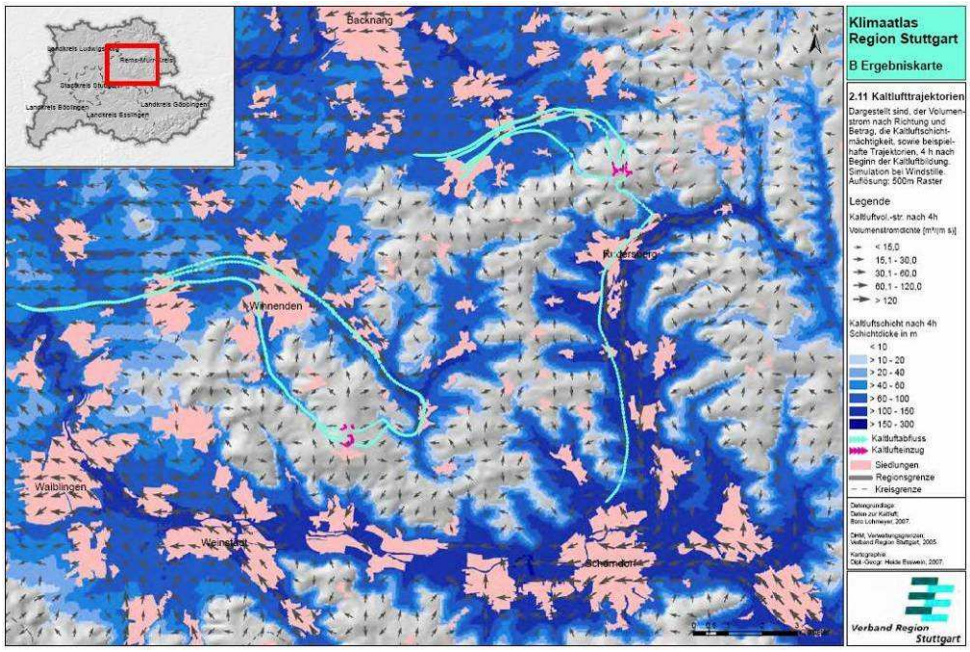

Figure 5 Direction of wind and intensity of cold air layers four hours after the beginning of cold air movement. The darker the blue, the thicker the layer of cold air. Light blue arrows indicate the direction of cold air flow; pink areas show settlements [3]

The Climate Booklet for Urban Development

In 1977, the City of Stuttgart published the first "Climate Booklet for Urban Development – Städtebauliche Klimafibel", which was then revised in 2008 and published online ("Climate Booklet for Urban Development Online – Städtebauliche Klimafibel Online") with support of the Ministry of Economy of the state of Baden-Württemberg. The booklet explains the characteristics of the local climate in Stuttgart and identifies the areas where particular planning and building regulations are needed to preserve or improve the air flow and generation of cool air in the city (based on the Stuttgart Climate Atlas).

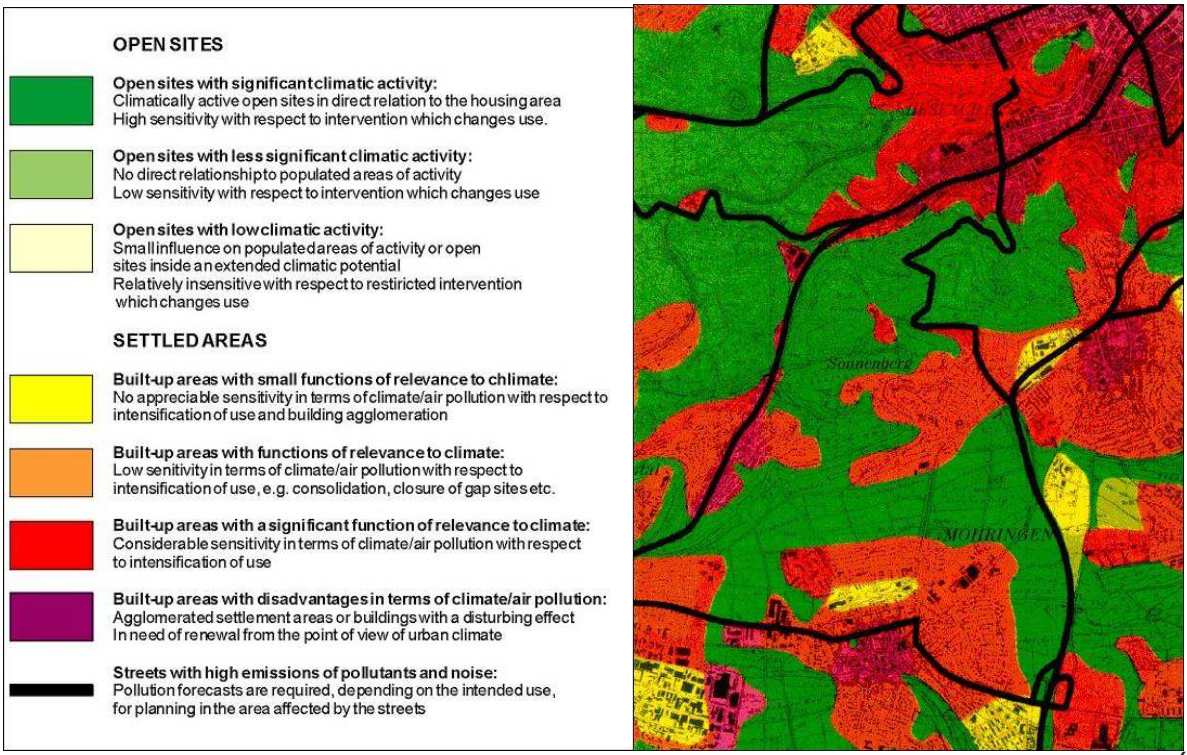

Figure 6. An example of a map presenting area categories used in planning for air flow in Stuttgart [6]

Table 1. Recommendations for development of different types of areas in Stuttgart [8]

Type of area	Characteristics of the area	Recommendations
Open Spaces with Important Climatic Activity	Direct relation to built-up areas (e.g. green spaces in the city); areas that lie upwind from built-up areas (undeveloped valleys, ridges, and gaps in terrain); large, connected open spaces near densely-settled areas. They are highly sensitive to changes in land use; construction of measures that hinder air exchange and soil sealing lead to significant impairments in climate function.	No large-scale construction or soil sealing permitted.
Open Spaces with Less Important Climatic Activity	No direct contact with developed areas or only minor role in cold air production (e.g. rocky or fallow lands); less sensitive to land use changes.	Large-scale development is permitted, as long as it does not substantially obstruct the regional air exchange and when climatically important local characteristics such as ridges, depressions or brooks are to taken into consideration during planning. To minimise the impairment of the climate function, preservation of green spaces and corridors, roof and façade greening, low building heights, and building orientation allowing air flows are recommended.
Open Spaces with Minor Climatic Activity	Lesser influence on developed areas; and relatively low importance for cold and fresh air production. Changes in land use are associated with only minor disturbances to climate. This category includes, for example, hilltops and large-scale, well-ventilated areas with level topography, distant from developed areas.	Development such as skyscrapers or large-scale commercial enterprises is possible in these areas. It should be ensured, however, that the ventilation conditions associated with the main wind direction remain unaltered. Also, no sensitive land uses should be planned in the vicinity of roads with heavy traffic to preserve air quality.
Developed Areas with Functions of Minor Climatic Relevance	Developed areas without high thermal or air-hygienic burdens that do not significantly impact neighbouring developed areas. No noteworthy climatic or air-quality sensitivity to intensifications of land use or expanded development (e.g. well-ventilated hilltops).	The existing ventilation conditions should remain intact and additional emissions should not bring negative effects on other developed areas. Roof and façade greening and the preservation of green spaces are recommended to prevent thermal problems.
Developed Areas with Functions of Climatic Relevance	Settlements of medium density with green spaces, which cool noticeably during the night and are relatively open to the wind; or well-ventilated dense development (e.g. hilltops). These areas do not produce intensive thermal or air-quality problems and do not impede air exchange. They have low climatic and air-quality sensitivity to land use changes.	The amount of developed land in the area should remain constant and soil sealing should be kept to a minimum. Soil sealing can be offset by the creation of green spaces as well as roof and façade greening.
Developed Areas with Functions of Significant Climatic Relevance	Sparsely-developed, areas with plenty green space and low building heights on the periphery of communities with nearly undisturbed air exchange; hillsides with development at their feet; areas with singular freestanding skyscrapers and green spaces; densely-developed areas whose climatic and air-hygienic footprint is not exceedingly high. The designated areas exhibit a substantial climatic and air-quality sensitivity to land use changes.	Further development and soil sealing measures would lead to negative effects on the climatic situation. Instead, an enlargement of the proportion of green space and the securing or expansion of ventilation spaces is recommended.
Developed Areas with Climatic and Air-Hygienic Disadvantages	Densely-developed areas that have significant climatic and air-quality problems. This category includes developed areas where air exchange is considerably hindered by buildings.	These areas require restructuring such as increasing the proportion of green space; minimizing the soil sealing; minimizing the level of emissions, especially traffic emissions; creation or expansion of greened ventilation corridors; removal or relocation of buildings disruptive to air flow where necessary.
Roads with High Air and Noise Pollution	Main traffic thoroughfares with a traffic count of more than 15,000 vehicles per day. The resultant high levels of air and noise pollution must be taken into consideration in planning.	Sensitive land uses (residential or recreational areas, agricultural land) should be planned only at sufficient distances from roads or with adequate protection measures.

In addition to responding to local climate characteristics, the following principles form the basis for the planning recommendations [6]:

- Areas of vegetation have an important effect on the local climate, due to cooling and shading, in particular by trees. Therefore, vegetation should be provided to surround developments and larger, connected green spaces should be created or maintained throughout developed areas to facilitate the air exchange.
- Valleys serve as air delivery corridors and should not be developed.
- Hillsides, and gullies and ridges on hillsides, should remain undeveloped, especially when development exists in valleys, since intensive cold- and fresh-air transport occurs here.
- Saddle-like topographies serve as air induction corridors and should not be developed.
- Urban sprawl is to be avoided.
- The development of commercial and industrial enterprises should ensure that the residential areas in the immediate vicinity do not suffer from heightened emissions of air pollutants.

Implementing the initiative

The Climate Atlas and the recommendations stemming from the climate maps included in the "Climate Booklet for Urban Development Online – Städtebauliche Klimafibel Online" [8] provide a uniform set of data to be used by the cities and municipalities in the Stuttgart Region, including Stuttgart, in their spatial planning and development control activities.

The main mechanism of implementation is the German Building Code, which provides a legislative basis for the solutions recommended by the Booklet. The Booklet lists the acts of law at the national and Land level which can be utilised in order to address issues relating to local climate. The regulations are divided according to different types of climate-amelioration mechanisms and different types of green infrastructure:

- Preservation and Acquisition of Green Space
  - Landscape and Open-Space Control Plan
  - Benchmarks for Describing "Green" Uses
  - Avoidance of Soil Capping; Green Spaces and Water
  - Roof Greening
  - Façade Greening
- Securing the Local Air Exchange
  - Cold Air Production
  - Fresh Air Supply
  - Green Corridors
  - Advantageous Forms of Development

The digital version of the Climate Atlas can also be used for the purposes of Strategic Environmental Assessment [4]. The greening of the city of Stuttgart is also supported by locally developed regulations. For example, Stuttgart protects all trees growing in the urban core with a trunk circumference of more than 80 cm at height of 1m with a tree preservation order. The conservation of these relatively big trees aims to revive the city's image, improve urban climate, and conserve habitats [7].

In the case of Stuttgart, the implementation of the recommendations in the Climate Atlas is carried out by the Office for Urban Planning and Urban Renewal, supported by the Office for Environmental Protection, which was also involved in the creation of the Climate Atlas 2008. The Office for Environmental Protection participate in the city planning process conducted by the Office for Urban Planning and Urban Renewal particularly through the provision of environmental information, consultation and producing environmental proposals. Their participation during the preparation of land use plans, framework plans for urban development and legally binding land-use plans is especially important. The Section of Urban Climatology within the Office for Environmental Protection evaluates the climatic implications of intended development and larger

buildings on the basis of meteorological measurements carried out since 1938, thermographic infrared measuring flights and increasingly on the basis of model calculations. This also includes the identification of climatic influences to which the intended development will be exposed. The Section aims to engage in early participation in building projects, early consultation with the Office for Urban Planning and also with architects and homeowners [(7)].

The planning recommendations stemming from the Climate Atlas are largely limited to structural changes of land use. This recognises that a change in the composition of vegetation exerts fewer climatic effects than large-scale soil capping measures and the erection of built structures for example. The planning recommendations are not specific to the level of individual parcels of land. As tolerances can range by up to 100 m, more detailed climatic analyses need to be carried out for specific site plans, especially in areas of high climatic and air quality sensitivity [(6)].

Sources of funding

The initiative was funded by the City of Stuttgart and the Verband Region Stuttgart. The funds were necessary to generate the climatic data around which the Climate Atlas is produced.

Stakeholder engagement

Collaboration with key stakeholders

The Climate Atlas 2008 was developed in close collaboration between the Verband Region Stuttgart (the association of regional cities and municipalities) and the City of Stuttgart. The Section of Urban Climatology within the Office for Environmental Protection of the city of Stuttgart contributed its specialist knowledge. The evaluation and processing of the data for the drawing up of the basic material for producing maps was undertaken by an external specialist consultant. Data from the State Institute for Environment, Measurements and Nature Conservation Baden-Württemberg (LUBW) and from the German Meteorological Service was also used during the process. The data was brought together by the Section of Urban Climatology [(4)].

Engaging the public

The City of Stuttgart emphasises the importance of public participation in greening strategies aimed at improving air quality and mitigation of the heat island effect. This is achieved through different strategies [(7)]:

- Since 1986, the City of Stuttgart has provided financial support to green about 60,000m^2 of roofs;
- Since 1992, a scheme has been in place for Stuttgart residents to adopt a tree. Today some 182 caretakers have adopted almost 500 trees. They are responsible for watering the tree, reporting pest attacks, removing the leaf litter and fallen branches, and protecting the tree from dog fouling.

Political buy-in

The Mayor of the City of Stuttgart supports the city greening initiatives aimed at improving of air quality and reducing in temperatures. Climate change adaptation and mitigation are both high on the political agenda locally, and the land use plan 2010 for Stuttgart envisages urban development under the slogan "urban – compact – green".

Can it have an impact?

In Stuttgart, over 39 per cent of Stuttgart's surface area has been put under the protection of nature conservation orders; a record in the whole of Germany [7]. As a result of greening actions, greenery covers more than 60 percent of the city [9]. Stuttgart contains 5,000 hectares of forests and woodland, 65,000 trees in parks and open spaces and 35,000 street trees. 300,000 m^2 of rooftops have been greened and 32 out of 245 kilometres of tram tracks have been grassed (as of 2007). In line with the city development vision, 60 hectares of greenfield land previously earmarked for development has been cut from the 2010 land development plan to protect existing green space [7].

However, the main success of the adaptation strategy based on preservation and enhancement of air exchange and cool air flows lies in targeted interventions such as a building ban in the hills around the town, and prevention of building projects that might obstruct the ventilation effect of nocturnal cold-air flows [10].

The success of the City of Stuttgart can be illustrated by the fact that several other German municipalities followed Stuttgart's lead developing a comprehensive environmental information database with the use of GIS. For example, the City of Berlin has built a comprehensive digital environment atlas of the city [10]. Also, the Stuttgart approach has been followed in other countries: the Stuttgart Climate Atlas methodology has been applied to Kobe City in Japan, where climatologists have worked with planners on measures to capture sea breezes by day and cold air drainage from the hills by night [11].

Key messages

- Compilation of detailed information about the area's topography, climate and land use allows for precise planning for different areas, which together aim to improve air quality and mitigate the urban heat island effect.

- The case demonstrates the advantages to a municipality of having in-house climatic research capacity to provide concrete knowledge of local conditions and remedies, as opposed to relying on an understanding derived from general principles. Cumulatively, over several decades, the city has used its planning and landscaping powers to engineer an entire system of urban wind circulation [10].

- Constructive use of existing regulations (e.g. the German Building Code) provides a mandate for the implementation of planning recommendations relating to local climate.

- Close collaboration between the Office for Environmental Protection (analysis of information, provision of recommendations) and the City Planning and Renewal team means that the recommended green infrastructure solutions are being implemented through spatial planning and development control.

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Slovakia: Development of open space standards

Climate change impacts addressed	Urban flooding High temperatures Poor air quality
Spatial scale	Country
Response type	Guidance
Themes driving the initiative	Development need despite climate impacts Adaptation to future climate Biodiversity conservation
Factors of success	Outsourcing research Cohesive delivery of multiple benefits

Summary

In Slovakia, the Ministry for Construction and Regional Development commissioned a group of experts in 2009 to update the set of national standards for land use planning, which were first developed in 2002. The standards include guidance for planning of open spaces and green areas. The standards describe not only the aspects relating to the quantity of open space in towns or in a given development, but also include aspects relating to the quality and character of open spaces, such as percentage of sealed surfaces, percentage of tree cover and accessibility. This exhaustive set of standards builds on examples from other European cities, including Berlin, Graz, and Malmö. The standards will be adopted by the Slovakian Ministry for Construction and Regional Development in December 2010 and will provide a non-statutory guidance for spatial planners and other departments in local authorities when taking decisions relating to land use planning and development control.

Case study location

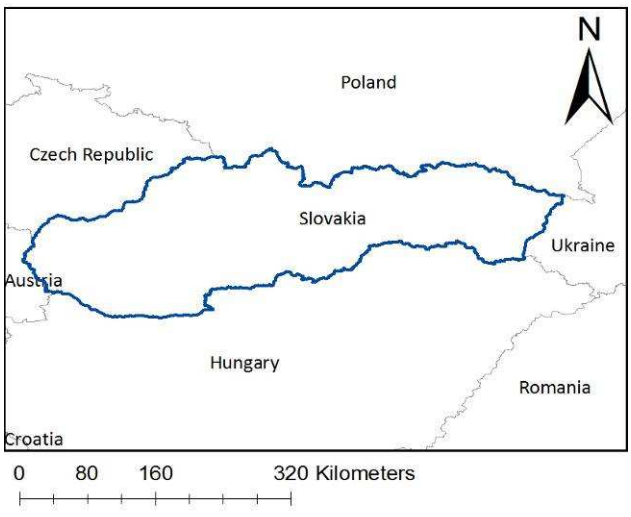

Figure 1. Location of Slovakia in Europe

Slovakia is a land-locked country in Central Europe (Figure 1), with a population of over 5 million and a surface area of about 49,000 km^2. The present-day Slovakia became an independent state on January 1, 1993 after the peaceful dissolution of Czechoslovakia, and its capital city is Bratislava. Western Slovakia and Bratislava are experiencing mass construction of housing (Figure 2), and due to the focus on maximising profit from these developments, principles of sustainable planning (e.g. control of urban sprawl, mixed land use, accessibility of open green spaces, basic services and transport, maintenance and management of natural environment and protection of cultural urban heritage) are being often neglected.

The Slovak climate lies between the temperate and continental characteristics with relatively warm summers and cold, cloudy and humid winters. The area of Slovakia can be divided into three kinds of climatic zones: lowland, basins climate and mountain climate. In the lowlands, the average annual temperature is about 9-10°C. The average temperature of the hottest month is about 20°C and the average temperature of the coldest month is greater than −3°C. The average temperatures in basins and mountains are lower.

In Slovakia, the average annual air temperature increased by about 1.1ºC and annual precipitation decreased by about 5.6% in the 20th century. However, in southern Slovakia, total precipitation fell by more than 10% although in the north and northeast of Slovakia an increase of up to 3% was documented over the century. Despite the overall decrease in precipitation, 1996-2000 were characterised by severe flooding.

According to future climate change scenarios, average temperature in mid-Slovakia could increase by as much as 5.2ºC in March and by 3.3ºC in November (3.8ºC average per year) for the period of 2081-2100, compared to 1971-1990. Extreme weather events such as heatwaves are also expected to increase in frequency and severity (1).

Figure 2. Green spaces and encroaching development in Bratislava (Photograph courtesy of REC Slovakia)

Development of the initiative

Key aims

The main aim of the initiative is to develop: "Standards for municipal infrastructure - A methodological guidance for land-use planning documentation". This document is being prepared for the Slovakian Ministry of Construction and Regional Development to provide a set of consistent quantitative and qualitative standards for open spaces, and will be targeted at spatial planners in order to guide them in decisions relating to land use planning and development control.

Themes driving the initiative

Development of standards for spatial planning
The main driver was the need to create a comprehensive set of standards relating to all aspects of land use planning expressed by legislation and regulations developed by the Ministry of Construction and Regional Development. In 2002, "Standards of minimal infrastructure of municipalities - methodological guide for authors of spatial planning documentation" was developed by the Ministry of the Environment of the Slovak Republic, which stated that in an

ecologically balanced settlement, over 60% of the area should be covered by vegetation. With the changes in legislation and regulations in the Slovak Republic since 2002, in part associated with the accession to European Union, a need was identified to expand upon and support the implementation of these standards [(2)].

Need to strengthen the role of green spaces in enhancement of ecology, adaptation to climate change, and improving the quality of urban realm

In relation to open and green spaces, the drivers listed in the "Standards for municipal infrastructure - A methodological guidance for land-use planning documentation" document include biodiversity and climate change adaptation. This is because it has been recognised in Slovakia, that many green spaces currently have very low ecological value, and that they play an important role in adaptation of cities to climate change impacts. It is also acknowledged that their role in these respects could be enhanced by adherence to quality standards. This thinking has been largely driven by the EU Directives and policy initiatives, such as European Spatial Development Perspective and the Environment Action Programme 6. Also, due to pressure from developers, the loss of green space to development, and the growing need for parking space, there needs to be tighter regulation in planning in order to improve the quality of the public realm and prevent further deterioration [(2)].

Participation in research projects

Another important driver was the engagement of the authors of the standards, the Regional Environment Centre Slovakia, in European research projects that involved exchange of experiences and information. These projects included UrbSpace [(3)], funded by the European Regional Development Fund, which aimed to improve environmental quality in smaller urban centres. Also significant is the GRaBS project (Green and blue space adaptation for urban areas and eco towns), funded by the Interreg IVC Programme, which aims to increase understanding of the role of green and blue spaces in adaptation to climate change and the implementation of such adaptation responses [(4)]. These projects have enabled exchange of experiences between different European municipalities and have increased the profile of issues including adaptation and green spaces in urban areas.

Details of the initiative

Chapter 5 of the "Standards for municipal infrastructure - A methodological guidance for land-use planning documentation" [(2)] includes standards focused on the quantity and character of open spaces. The criteria address quantitative (i.e. concerning the amount of open space) and qualitative issues (i.e. relating to the characteristics of open spaces such as percentage of vegetation, percentage of surfaces permeable to water, percentage of tree cover, and other indexes associated with the functional use of open spaces). In addition, an accessibility component deals with the need to create an inter-linked networks of open spaces distributed accordingly to the urban population.

The standards take into account various hierarchies of importance of open spaces, issues of spatial scale (city, district, local) as well as the prevailing functions of the spaces. The standards are also categorised according to the size of the municipality (number of residents). Table 1 provides an example of the quantitative standards in relation to provision and accessibility of open space. Table 2 provides an excerpt of the standards focusing on the quality of green spaces.

Table 1. Quantitative standards for the provision of open space (excerpt) [5]

Open spaces		STANDARD FOR SIZE CATEGORY OF MUNICIPALITIES IN THOUSANDS OF INHABITANTS						
category	**Indicator**	**- 5**	**5 - 10**	**10 - 20**	**20 - 30**	**30 - 50**	**50 - 100**	**+ 100**
Parks, public gardens and green spaces	Minimum park area	5 000 m², and minimal width 25m	5 000 m², and minimal width 25m	5 000 m², and minimal width 25m	5 000 m², and minimal width 25m	5 000 m², and minimal width 25m	5 000 m², and minimal width 25m	5 000 m², and minimal width 25m
	[m²/inhabitant]	8-14	8-14	8-14	8-14	8-14	8-14	8-14
Local level	[m²/inhabitant]	8-14	8-14	2-5	2-5	2-5	2-5	2-5
	accessibility	300 m	300 m	300 m	300 m	300 m	300 m	300 m
District level	[m²/inhabitant]			2-5	2-5	2-5	2-5	2-5
	accessibility	-	-	1.2 km	1.2 km	1.2 km	1.2 km	1.2 km
City level	minimum area [ha]			5	5	5	5	5
	accessibility	-	-	3.2 km	3.2 km	3.2 km	3.2 km	up to 5 km
Other green spaces								
Playgrounds, sport facilities	min. area [ha]/ 1000 inhabitants	0.8 ha per 1,000 inhabitants	0.8 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants	0.8 – 1.6 ha per 1,000 inhabitants
• Playgrounds for small children	Accessibility within	up to 150 m	up to 150 m	up to 150 m	up to 150 m	up to 150 m	up to 150 m	up to 150 m
• Playgrounds for children of 10-13	Accessibility within	up to 300 m	up to 300 m	up to 300 m	up to 300 m	up to 300 m	accessibility within 300 m	accessibility within 300 m

Table 2. Quality standards related to the % of vegetated surfaces and tree cover for the characteristics of green spaces, open spaces and external spaces in different types of development (excerpt) [5]

Open spaces		STANDARD FOR SIZE CATEGORY OF MUNICIPALITIES IN THOUSANDS OF INHABITANTS						
facility	**indicator**	**- 5**	**5 - 10**	**10 - 20**	**20 - 30**	**30 - 50**	**50 - 100**	**+ 100**
Parks, public gardens and green spaces	[% of vegetation surfaces]	80%	80%	80%	80%	80%	80%	80%
	[% of coverage by woody plants]	60%	60%	60%	60%	60%	60%	60%
Local level	[% of vegetation surfaces]	80%	80%	80%	80%	80%	80%	80%
	[% of coverage by woody plants]	60%	60%	60%	60%	60%	60%	60%
District level	[% of vegetation surfaces]	80%	80%	80%	80%	80%	80%	80%
	[% of coverage by woody plants]	60%	60%	60%	60%	60%	60%	60%
City level	[% of vegetation surfaces]	80%	80%	80%	80%	80%	80%	80%
	[% of coverage by woody plants]	60%	60%	60%	60%	60%	60%	60%
Civic space (sealed surfaces), roads and other transport routes								
• Urban squares and plazas								
Local level	[% of vegetation surfaces]	Min. 30%	Min. 30%	Min. 30%	Min. 30%	Min. 30%	Min. 30%	Min. 30%
	Index of impermeableness	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%
District level	[% of vegetation surfaces]	30%	30%	30%	30%	30%	30%	30%
	Index of impermeableness	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%	max. 40%
City level	[% of vegetation surfaces]	20%	20%	20%	20%	20%	20%	20%
	Index of impermeableness	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%
• Pedestrian streets	Index of impermeableness	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%	max. 45%
• Residential streets	Number of trees per 1 km	80 pc as minimum	80 pc as minimum	80 pc as minimum	80 pc as minimum	80 pc as minimum	80 pc as minimum	80 pc as minimum
• Other roads	unlimited	unlimited	unlimited	unlimited	unlimited	unlimited	unlimited	unlimited

Implementing the initiative

The land use planning standards document was developed in 2009. During the first half of 2010, the Ministry of Regional Development and Construction forwarded the document to its sub-ordinary bodies, to all other Slovak ministries, and to the Union of Slovak cities and towns for consultation. Comments will be considered upon their collection and incorporated into the document where relevant. As of June 2010, no comments on the chapter of open spaces and greenery were submitted. The document will be formally published in December 2010. At this point, the standards will be available to local planners, who will be responsible for their use in local land use planning decisions and actions.

Building the evidence base

Development of the standards was largely based on experiences learnt from the following areas:

- Berlin, Germany, where the Biotope Area Factor is used to guide developers to secure an appropriate proportion of green space in their developments.
- Graz, Austria, where "Standards for open spaces in built-up areas" (Freiraumplanische standards fur die Baulandgestaltung) sets an index of surface permeability, which is applied to developments.
- Malmö, Sweden, where a "green space factor" was applied in construction of the new district Vastra Hamnen, which ensures that each plot of land has a minimum amount of greenery. On a scale from 0 to 1, the average factor must be at least 0.5 (6).
- Great Britain, where the "Six Acre Standard" specifies the provision of playing fields in cities, and the "Accessible Natural Green Space Standard" describes the provision of green spaces of more natural character in urban areas (7).

The potential impacts of climate change in Slovakia guided the selection of standards of open space provision, as well as the aspects relating to the quality of green spaces, such as provision of trees and an index of permeability.

Monitoring and evaluation

Due to the non-statutory character of the standards, no plans for monitoring their implementation or effectiveness have been made.

Sources of funding

The development of standards for open space was funded by the central Government in Slovakia, i.e. the Ministry of Construction and Regional Development.

Stakeholder engagement

Collaboration with key stakeholders

The work on the standards was ordered by the Ministry of Construction and Regional Development. However, the process of developing the standards involved experts from a range of different disciplines. The main stakeholder involved and leading the development of the standards was the Institute of Urban and Territorial Planning URBION (Inštitút urbanizmu a územného plánovania URBION) in Bratislava. Other experts came from the Slovak University of Technology, Faculty of Architecture (responsible for standards related to spatial planning for education, health,

social care, culture, sport, recreation, etc), and from the Regional Environmental Centre in Bratislava (responsible for the development of standards for open spaces). The study also involved independent experts, and the work was coordinated by AŽ PROJEKT – a company specialising in urban design and land planning studies.

Political buy-in

The standards prepared by the group of experts will be discussed by a committee consisting of members of different Ministries. This will assist in making necessary changes to the standards, and will also help in gaining political buy-in for their implementation.

Can it have an impact?

Scope of adaptation

The development of tight standards guiding spatial development and land use planning is a novel approach in Slovakia and in other post-communist countries. The standards will refer both to the new developments, but also more importantly to the reconstruction of existing developments. Inclusion of standards relating to tree canopy cover may have a significant effect in changing the way open spaces look in Slovakian cities, and whether they are able to provide appropriate shading and cooling in light of the changing climate. The standards include recommendations not only for distinctive green spaces, but also for open spaces associated with developments. Therefore, the standards provide a comprehensive guide for planning of all open spaces in all Slovakian settlements. This makes it a very powerful tool, which could result in significant increase of vegetation cover and surface permeability assisting with adaptation to climate change impacts. Moreover, the standards are not only relevant to spatial planners, but also to other decision makers in local authorities. For example, the Building Office for developers may require a change in a development due to conflict with the standards in order to grant planning permission.

However, the main caveat is that the standards are not statutory. They have been produced purely as guidance and local planners and developers will not be obliged to follow them. Therefore, it is not certain that the standards will be fully utilised by decision makers. Nevertheless, the standards represent a step in the right direction and help to build capacity to adapt to climate change impacts in Slovakia.

Key messages

- Cooperation with experts and environmental non-for-profit organisations resulted in the development of a comprehensive set of standards. It is clear that the use of the local knowledge base, such as research institutes or universities, is hugely beneficial when developing evidence-based standards.

- Learning from others was crucial – the standards for open spaces were based on British standards for the provision of open spaces, and also on experiences of cities in Sweden, Austria and Germany. This emphasises the need for exchange of experiences.

- Learning from other cities and countries was mainly made possible by participation in international projects, such as UrbSpace and GRaBS.

- Creation of a very specific set of standards for spatial planning may be a useful solution for countries where spatial planning legislation and procedures may not be strong enough to withstand pressure from developers.

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Seattle: Using vegetation to limit the hazard of landslides

Climate change impacts addressed	Ground instability
Spatial scale	Town or city
Response type	Regulations
Themes driving the initiative	Response to current climate Development need despite climate impacts Higher-level policy framework
Factors of success	Internal collaboration External collaboration Outsourcing research Sound evidence base Public engagement

Summary

Landslides are a widespread, frequent, and costly hazard in Seattle (Washington State, USA) due to the area's post-glacial geology, topography characterised by steep slopes, and climate with wet winters and frequent rain showers. Climate change is likely to increase ground instability in the area by exceeding the safe saturation levels of soil through more frequent and intense precipitation. After disastrous landslides in winters of 1995-96 and 1996-97, the City of Seattle in collaboration with the US Geological Survey and the State of Washington has carried out extensive research to identify the areas prone to landslides, and issued regulations on how landslide risk could be prevented. The regulations within the Seattle Municipal Code include detailed requirements on the maintenance and restoration of vegetation in areas prone to landslides. These regulations are also presented by the Department for Planning and Development to Seattle residents in form of user-friendly "Client Assistance Memos" and through public meetings.

Case study location

Seattle, Washington, is the northernmost major city in the United States, located on Puget Sound (a complex system of estuaries and marine basins; Figure 1). The city's population is approximately 600,000 within a metropolitan area of about 4 million. With the exception of coastal California, Seattle suffers more damage from landslides than most other large cities in the United States [(1)]. This is because Seattle's geology is characterised by glacial, alluvial and marine sediments [(2)]. This type of ground, in combination with steep slopes, makes the Seattle area prone to landslides. These mainly occur following heavy rainfall or snowmelt [(3)], and predominantly during the winter season (October through April) [(2)]. There is a clear correlation between the amount of rainfall and the incidence of landslides (Figure 2).

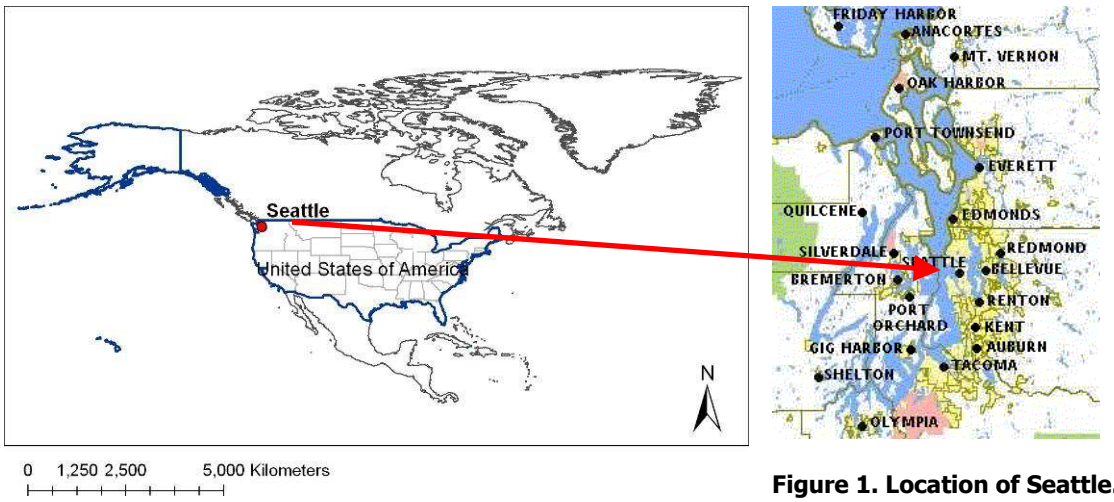

Figure 1. Location of Seattle.

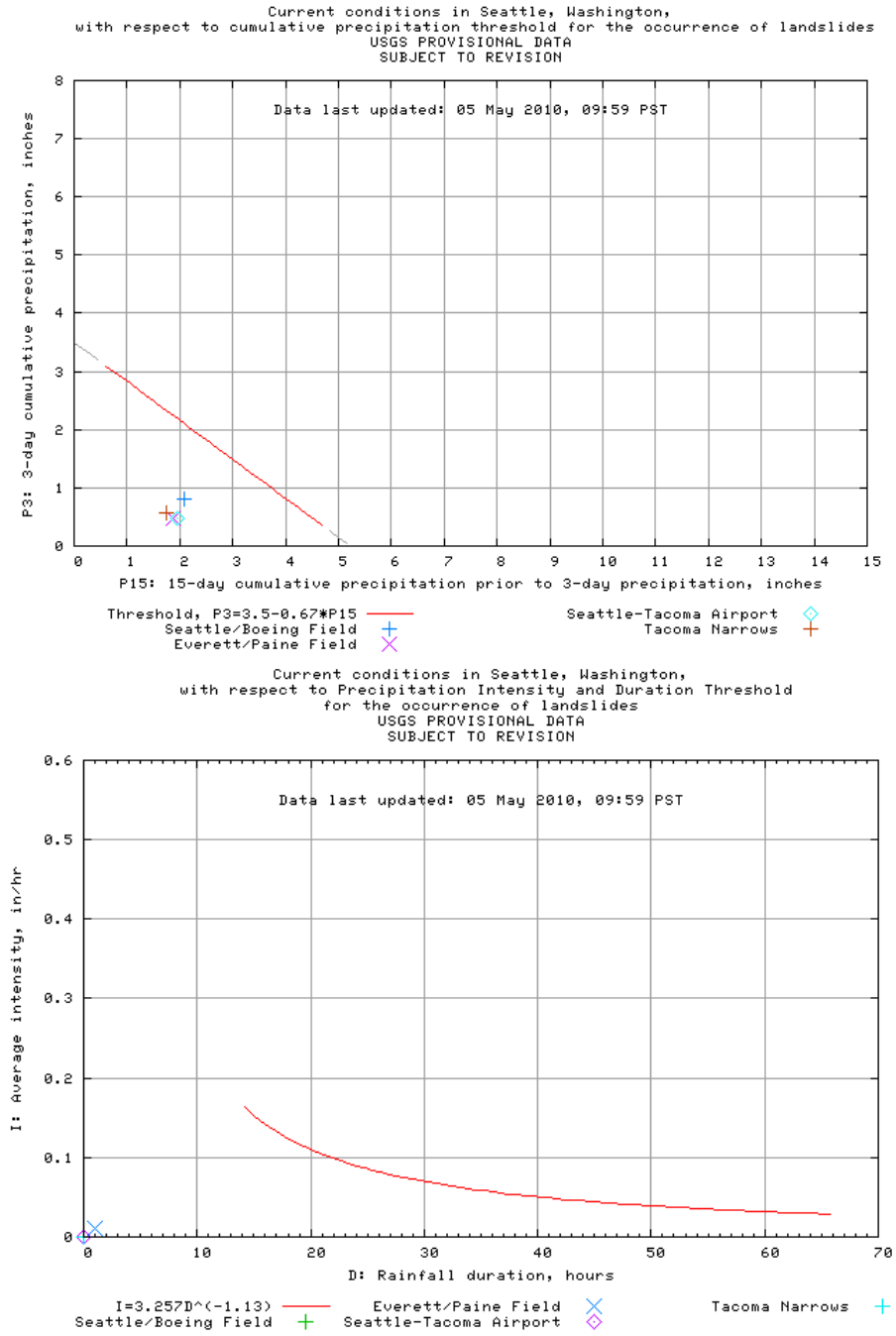

Figure 2. Cumulative precipitation threshold and rainfall intensity/duration threshold in Seattle [4]

Winter storms have triggered significant numbers of landslides in 1934, 1972, 1986, 1990, 1996, 1997, and 2001. Landslides in 1996 and 1997 caused major damage to private and public property and resulted in the deaths of four people. Although Seattle regulates development on steep hillsides, damage caused by landslides continues for several key reasons. They include pressure to build on or near landslide-prone areas to maintain economic growth and development; increased soil erosion caused by urban runoff which reduces slope stability locally; and as a result of ongoing damage to structures that were built in unstable areas before regulations existed [2].

Seattle's climate is usually described as temperate Oceanic or Marine west coast, with mild, damp winters and relatively dry and mild summers. Climate change projections suggest that the annual temperatures in the Pacific Northwest will be almost 2ºC higher by the 2020s and almost 3ºC higher by the 2040s, compared against 1970-1999 averages. Warmer temperatures means that more precipitation will fall as rain not snow, and that more snow will melt earlier in the spring [5].

Such conditions, and more frequent extreme weather events such as periods of intense rainfall, are likely to increase the likelihood of landslides through increased erosion and ground saturation.

It is also significant that 84% of landslides in Seattle are caused by reasons which include a human factor. These include improper drainage, broken or leaking pipes, excavation at the toe of a slope, fill placement at the top or side of a slope, imprudent cutting of vegetation, and the lack of maintenance of drainage facilities or vegetative cover. This suggests that countermeasures can be implemented by the City and private property owners to reduce the risk of damage to public and private properties resulting from landslides [(1)].

Development of the initiative

Key aims

The collaborative research undertaken by the City of Seattle, the State of Washington and the US Geological Survey aimed to produce a detailed inventory of landslide-prone areas in Seattle and developing a better understanding of how to prevent landslides. Based on the findings of this research, the regulations issued by the City of Seattle now provide developers and land owners in the areas of risk with a regulatory framework and associated guidance on the provision, maintenance and restoration of vegetation. The goal of this approach is to contribute to stabilising slopes and removing excess water from the ground in areas of risk, therefore reducing landslide risk.

Themes driving the initiative

Frequent occurrence of landslides in the area
Shallow earth slides triggered by heavy rainfall are the most common type of landslide in the Seattle area, many of which transform into debris flows and cause significant property damage or disrupt transportation. The hundreds of landslides that occurred during the winters of 1995–96 and 1996–97 stimulated renewed interest in identifying landslide-prone areas and taking actions to reduce future landslide losses [(2)].

State legislation
The State of Washington, through Growth Management Act, requires that all local jurisdictions identify and delineate Environmentally Critical Areas (which, among others, include geologically hazardous areas), as well as adopt and implement zoning ordinances with development standards to protect these areas [(6)].

Previously existing data on landslides
The first database of landslides in the area was set up in the 1960s and has been updated periodically. As a result, prior to the 1995/96 and 1996/97 rainfall seasons, the City of Seattle had among the most comprehensive historical records of landslides in the US [(1), (7)]. This database provided an important resource that assisted the completion of the landscape study [(7)].

Role of vegetation in preventing landslides
Vegetative cover can contribute to improving the stability of steep slopes by reducing erosion, reducing direct infiltration from rainfall, and increasing the strength of the near-surface soil. Dense vegetation intercepts direct rainfall before raindrops impact the soil surface, thereby reducing or eliminating rainsplash erosion. With dense vegetative cover and thick forest litter, the overland flow is also reduced in intensity and speed, lessening surface erosion. Thick vegetation, forest litter, and organic soils retain moisture from direct precipitation, and evaporate the water back to the atmosphere. Root systems can increase the strength of the soil they penetrate, reducing the

likelihood of shallow landslides; and the deeper the roots, the better the protection in this respect. Native vegetation is best because it can be maintained without irrigation during the dry season. However, certain types of vegetation can have an adverse effect on slope stability, e.g. unstable trees can initiate a landslide if they are toppled during high wind conditions [(1)].

Details of the initiative

In 1997, following the disastrous landslides of that year, the City of Seattle prepared a detailed policy and strategy document on landslide hazard mitigation. Legal mandate for related actions was established through resolutions. The first resolution established a framework for an integrated policy on landslide hazard mitigation. This emphasised the City as regulator, property owner, provider of utilities and services, and interdepartmental coordinator. Through a second resolution, the City defined principles to guide its goals and policy framework which included public safety, maintaining infrastructure and service standards; risk management to reduce losses to the city's own property. In 1998 a third resolution was adopted to guide development of programmes relating to reducing the risk of landslides [(7)].

Under the first resolution the City of Seattle established the Interdepartmental Landslide Team to work on protecting public infrastructure in landslide-prone areas. The Team consisted of representatives from Seattle Public Utilities, Seattle Department of Transportation, Seattle Department of Parks and Recreation and the Department of Design, Construction and Land Use (now Department of Planning and Development - DPD) [(8)]. The main tasks of the team included development of new policies and public outreach.

In parallel (1996) the US Geological Survey (USGS) started a project to examine earthquake, flood, landslide, and volcano hazards in the five counties bordering on Puget Sound. In 1998, the Federal Emergency Management Agency (FEMA) launched a hazard mitigation program known as Project Impact, and selected Seattle as one of its pilot cities [(2)]. This recommended that the City cooperate with the USGS. Consequently, the City of Seattle, the City's contractor, Shannon & Wilson consultancy, the USGS, and the University of Washington began cooperative efforts in 1998 to create a detailed three-dimensional geologic model and database of landslides utilising tens of thousands of existing geotechnical subsurface explorations.

As a result of the collaboration, a scientific base was developed to take action to respond to the problems associated with landslides. This enhanced knowledge base included the landslide map of Seattle, a report and map showing landslide susceptibility, a map showing density of landslide occurrence, 3D modelling of slope stability in coastal areas, rainfall thresholds for forecasting landslides, and an extensive database of 1,400 landslides that have occurred in the City of Seattle over the last 100 years.

The knowledge base is now integrated into decision making in Seattle, and provides a scientific basis for review and prioritisation of public projects [(7)]. The Environmentally Critical Areas were delineated to indicate landslide risk areas and the Interdepartmental Landslide Team has developed policies for these, to enhance uniform administration, building codes and utility standards promoting slope stability [(8)]. These policies are included as regulations in the Seattle Municipal Code (a compilation of the general and permanent ordinances of the City of Seattle) [(9)]. The Code is divided into titles, chapters and sections. The most relevant to the use of vegetation as a preventive measure for landslides is Title 25. This relates to Environmental Protection and Historic Preservation and includes those provisions of the Code which relate to protection of the environment, historical areas and landmarks. The following sections in Chapter 25.09 – Regulations for Environmentally Critical Areas specify the use of vegetation in landslide areas:

Seattle Municipal Code 25.09.180 - Development Standards for Steep Slope Areas, which applies to parcels containing a steep slope area or buffer. It reads that techniques used in

construction should keep the disruption of existing topography and vegetation to a minimum. Also, if removal of trees or vegetation in a steep slope area and its buffer is authorized as part of approved development, it shall be kept to a minimum, and shall be carried out pursuant to a tree and revegetation plan described in section 25.09.320. Other removal of, clearing or any action detrimental to trees or vegetation in a steep slope area or buffer is prohibited, except as provided in Section 25.09.320 (see below for further details). In addition to complying with Section 25.09.320, any replanting that occurs shall consist of native vegetation.

Seattle Municipal Code 25.09.320 - Trees and Vegetation
This code states that within landslide-prone areas, removing, clearing, or any action detrimental to habitat, vegetation or trees (such as topping, or removal of parts of branches to reduce the canopy) is prohibited, with exception specified further in the text. The actions which are permitted include:

- Normal and routine pruning and maintenance of: trees and vegetative cover (in some cases limited to 70 m^2), lawns and landscaping, and steep slopes;
- Removing trees or vegetation as part of an issued building or grading permit consistent with a tree and revegetation plan, provided that the work has been filed with DPD. If the area exceeds 140m^2, the plan needs to be approved by the Director of DPD, and the work needs to be carried out under the direction of approved professional.
- Restoring or improving vegetation and trees, including removing non-native vegetation or invasive plants and noxious weeds by hand, to promote maintenance or creation of a naturally functioning condition that prevents erosion, when the restoration or improvement is a condition to obtaining a permit or approval from the Director; or when appropriate permits have been achieved (if the area exceeds 140 m^2, calculated cumulatively over 3 years, or if the removal of invasive plants or noxious weeds is done by machine or chemicals, the plan must be approved by the Director of the DPD, and the work must be carried out under direction of a qualified professional).
- Removing trees or vegetation when the Director determines the tree or vegetation is a threat to health or safety based on a report prepared by a qualified professional and the removal is performed by or under the direction of a qualified professional.

As a minimum, plans for removal, maintenance and restoration of vegetation need to be consistent with the Department's standard tree and vegetation plans. For areas over 70 m^2 the plan needs to be approved by a geotechnical engineer or geologist licensed in the State of Washington with experience in analyzing geological hazards related to slope stability and vegetation removal on landslide prone areas. For the largest areas (over 140 m^2) plans shall be prepared by a qualified professional with experience related to the type of environmentally critical area or buffer where work will occur. All plans need to be consistent with best management practices.

Implementing the initiative

Department of Planning and Development assists in the City's preparedness efforts for possible landslides by providing Seattle residents with information to help homes and businesses prepare for a potential landslide; by inspecting residences and businesses to make sure these structures meet City codes and regulations upon approval of a DPD permit; and by providing rapid evaluations and expedited emergency repair permits for structures damaged by a landslide [(10)].

Building the evidence base

The scientific approach to data collection and processing was essential to the development of landslide hazard reduction policies and initiatives in Seattle. This emphasis on a scientific approach is partly due to the State regulations. The Revised Code of Washington (RCW) stipulates: In designating and protecting critical areas under this chapter, counties and cities "shall include the

best available science" in developing policies and development regulations to protect the functions and values of critical areas [7]. This approach aids the landslide policy decisions taken by City officials, and increases public knowledge of landslides in the City [7]. The development of the landslide database, which allowed identification of the environmentally critical areas in Seattle, was based on research processing a vast amount of information including consideration of geology, topography and climate data. One of the most important meteorological characteristics is the amount of rainfall, and its intensity, that is likely to result in landslides in the areas identified as being at risk (Figure 2). Such data allows projections of the threat of landslides to be made under future climate scenarios.

Monitoring and evaluation

In 2007, the USGS enlisted the help of a local planning firm, Planwest Partners, Inc., to help evaluate how research on landslide hazards in the Seattle area, conducted by USGS, was used. This was undertaken using the following methods:

- the review of the research by USGS, the City of Seattle, and its contractor, Shannon & Wilson, Inc., concerning landslide hazards of the region;
- interviews with numerous Seattle public officials and others who were instrumental in landslide hazard reduction policy;
- two roundtable discussions, the first with the representatives of agencies who were involved in setting landslide hazard reduction policies, and the second with USGS scientists who conducted research in the Seattle area;
- review of Washington State and Seattle regulations and laws that encouraged passage and enforcement of landslide hazard reduction policies [7].

Sources of funding

In 1998 FEMA provided a $1 million grant to Project Impact to stimulate additional funding in Seattle [2]. Within the City structures, establishment of the Interdepartmental Landslide Team enabled creation of a dedicated funding stream associated with activities of all departments involved in related work. The City's cooperative approach allowed departments to leverage funds for landslide hazard reduction from multiple funding sources. The Interdepartmental Landslide Team contributed funding for the University of Washington and USGS to develop GIS soils layers, and it provided funding for educational workshops for the public (see public engagement section below) [8]. Seattle also established a new funding mechanism, which authorized the collection of drainage management fees, and gave the City of Seattle a new revenue source to implement landslide hazard mitigation initiatives [7].

Stakeholder engagement

Collaboration with key stakeholders

The lead authority on the initiative is the City of Seattle. The implementation by the City of policies on the use of vegetation in areas prone to landslides is enforced through the Seattle Municipal Code under the lead of the Department of Planning and Development. However, compilation of the geological and climate information necessary to identify areas of hazard and effective measures of preventing landslides was only possible through cooperation between governments at local, state and national level, alongside involvement of research institutes and consultancies. Land use and development decisions are usually made at the local level. State governments enact general requirements that facilitate the development and implementation of local policies. At the national level, federal government agencies such as the USGS have a minimal role in land-use planning and enforcement but do provide information that may be of use to local governments as they

implement land use and hazard reduction policies. In the Seattle area, it is clear that each level of government brought different capabilities to the task of reducing the City's exposure to future damage from landslides [7].

The State of Washington contributed to the success of the adoption of landslide hazard reduction policies through the Growth Management Act (GMA) that requires all local jurisdictions, such as Seattle, to identify and regulate geologically hazardous areas [6]. While Seattle selected Shannon and Wilson, Inc., to compile a digital database of city-wide landslide information dating from 1890 to the present, this landslide and topographic data was made freely available to the USGS for use in its studies. In return, USGS landslide techniques were used to identify geologically hazardous areas and the City departments were given information about how the USGS developed these techniques and how to use them in practice [7]. More recently, cooperation between county, state, and federal agencies has resulted in the acquisition of high-resolution topographic data by LIDAR for most of the Puget Sound region, including the city of Seattle [2].

Engaging the public

Alongside the gathering of scientific data, public outreach was undertaken at the early stages of the development of City of Seattle policies for the prevention of and better response to landslides. During 1997-1998, citizen comments on the approach were collected during a series of five public meetings [1].

Scientific studies completed within the USGS Seattle Landslide Project were made available to the public and communities interested in the implementation of landslide reduction approaches. These documents are freely available on the City of Seattle website [11].

Regular educational workshops on landslide hazards and mitigation approaches are organised for the Seattle residents. Between 1997 and 2004, 12 such workshops were attended by 950 members of the public. The meetings are still happening. Indeed, in 2009 the City of Seattle set up two free public landslide awareness meetings, which included a discussion on the causes of landslides, proper drainage for sloping sites, and vegetation maintenance on slopes. This was followed by a question and answer session and time for one-on-one discussions with professionals in the field, including the City of Seattle, The American Society for Civil Engineers, The Association of Engineering Geologists, The International Society of Arboriculture, and Associated Building Contractors (Figure 3).

In addition, the Department of Planning and Development produces a series of Client Assistance Memos (CAMs) that topically summarise the regulations affecting property owners and developers in Seattle and provide advice on permits that need to be obtained to perform given actions relating to the development and use of land.

CAM 324 "Reducing landslide and stormwater erosion damage: what you can do" [12] suggests stabilising slopes with the use of vegetation: *"Improve your soil's ability to resist erosion by stabilizing slopes with mulching and any of a number of plantings, including grass, ground covers, and trees. However, stable native vegetated slopes should not be disturbed and a grading/building permit may be required if any filling or excavation is performed."*

The requirements of Seattle Municipal Code 25.09.320 were included in CAM 331 "Environmentally Critical Areas: Tree and Vegetation overview" [13], which explains to land owners and developers which planting, pruning and vegetation removal actions are allowed in areas under risk of landslides.

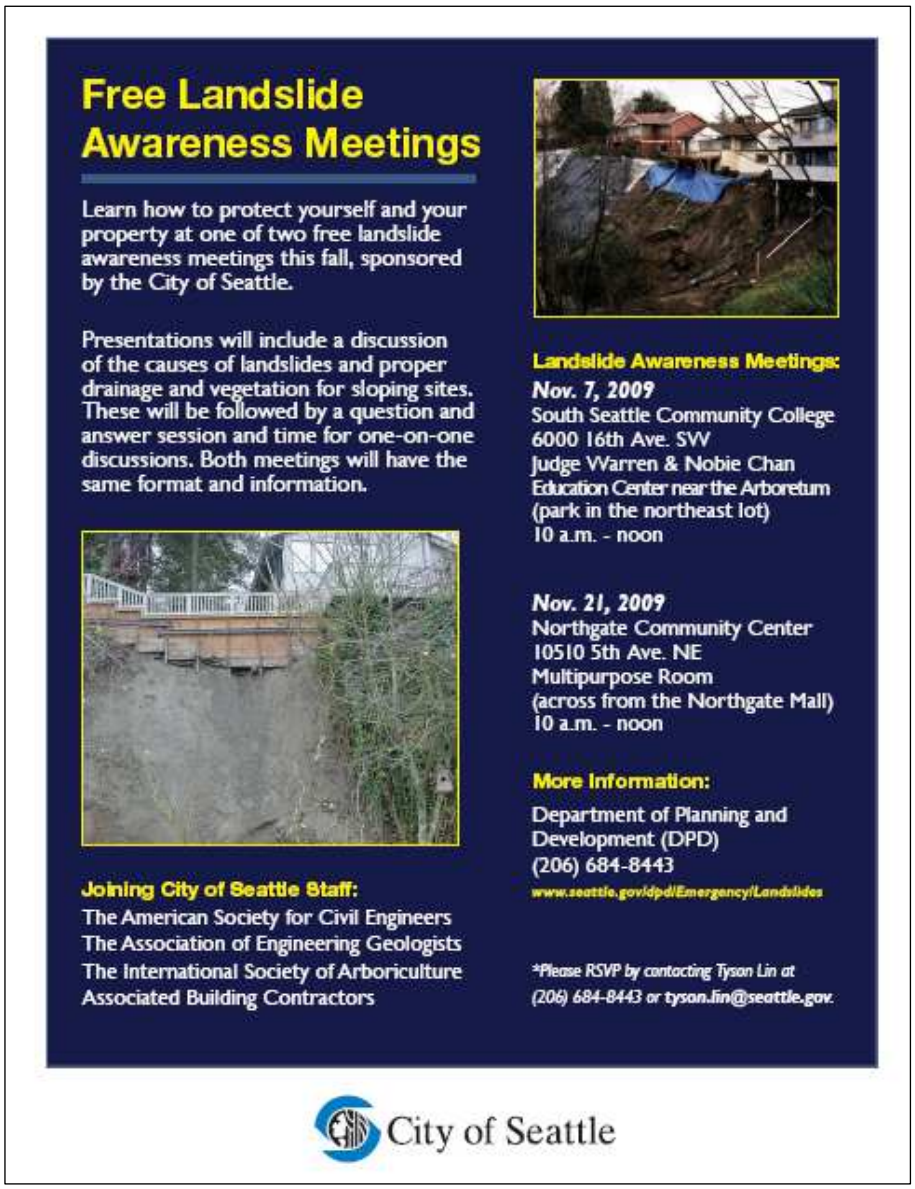

Figure 3. An example of a leaflet inviting Seattle residents to public meetings

CAM 331a "Environmentally Critical Areas: Vegetation Restoration" [(14)] emphasises that vegetation restoration projects in areas prone to landslides can play a critical role in improving the health and function of these areas. It provides step-by-step instructions to designing and implementation of a vegetation restoration project (assessment of location, preparation of a plan, choosing the plants, preparation of the site, carrying out the planting, monitoring and maintenance), as well as links to additional information. CAM 331a reads that: *"Restoration should result in a densely vegetated area with a significant diversity of native trees, shrubs and groundcover."*

CAM 331a offers a list of recommended native tree, shrub and groundcover plants and specifies the conditions they grow best in, including those that can grow on steep slopes, and consequently stabilise them without the risk of the tree falling over (Figure 4). It is emphasised that in assessing the effectiveness of restoration actions, it is important to consider the ecological function of existing mature trees and avoid removing existing tree canopy cover when possible [(14)].

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Recommended Native Plant List

LIGHT NEEDS
○ = Full Sun
◑ = Partial Sun / Partial Shade
● = Full Shade

SITE PREFERENCE
Water's Edge = Edge of stream, wetland or freshwater shoreline
Wet = Soils that usually hold water or are very near water table
Standard = General condition of soil in Seattle (may hold water
Steep = Also appropriate for Steep Slopes

Trees

Quantity	Common Name	Scientific Name	Average Ht.(ft.)	Light Needs	Site Preference	Comments
	Cascara	*Rhamnus purshiana*	25	◑ ●		Good for riparian
	Douglas fir	*Pseudotsuga menziesii*	200	○		Fast grower
	Oregon Ash	*Fraxinus latifolia*	70	○ ◑		
	Pacific willow	*Salix lasiandra*	40	○ ◑ ●		Prefers riparian
	Shore pine	*Pinus contorta*	40	○ ◑ ●		Tolerates poor soil
	Sitka willow	*Salix sitchensis*	25	○ ◑ ●		
	Vine maple	*Acer circinatum*	15	●		Slow grower
	Western Hemlock	*Tsuga heterophylla*	150	○ ◑ ●		Not drought-tolerant
	Western Red Cedar	*Thuja plicata*	150	◑ ●		

Figure 4. Recommended native plant species (excerpt) [14]

Can it have an impact?

The collection of extensive information about landslides, and developing a database of historical recorded events, helped to systematically build knowledge about the areas prone to landslides. This has in turn allowed the delineation of zones (the Environmentally Critical Areas) where policies should be applied to manage landslide risk. The review of the Seattle Landslides Project by an independent company has helped to ensure that the process is meeting criteria of both scientific rigour and appropriate conduct of a public body.

Extensive public outreach and translation of policies in the Seattle Municipal Code into publically accessible Client Assistance Memos, supplemented by the awareness-raising meetings, has helped to ensure that the residents of Seattle are familiar with the City's policies on managing the risk of landslides and are therefore more likely to follow them.

The use of vegetation in mitigating landslides is emphasised by many policies. However, it is also acknowledged that vegetation is only one of many measures that could be applied to help stabilise slopes. The role of vegetation is not overestimated, and the expectations of what can be achieved by greening steep slopes are therefore realistic and proportionate.

Key messages

- Extensive scientific research has provided a sound scientific base for decision-making in relation to landslides.
- Scientific research results were also used to increase levels of awareness of general public of landslide issues through a programme of meetings and educational brochures.
- Involvement of government departments at different levels, alongside subcontracting work to private companies, allowed the use of the best available information, competences and skills across a range of different organisations.
- Inter-departmental collaboration was important in tackling the problem of landslides in Seattle, and also enabled tapping into different funding sources that would otherwise be off limits to this kind of initiative.
- The evaluation of the process leading to establishment of the evidence base, carried out by an external company increased its reliability and justified spending of public money on the development of an approach to manage landslide risk.

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New Orleans: Preserving the wetlands to increase climate change resilience

Climate change impacts addressed	Sea level rise Storms and hurricanes
Spatial scale	Town or city
Response type	Action plan
Themes driving the initiative	Response to current climate Adaptation to future climate Biodiversity conservation
Factors of success	External collaboration

Summary

Following the disastrous failure of structural flood defences during Hurricane Katrina in 2005, the State of Louisiana and the City of New Orleans have undertaken steps to increase the resilience of the city to sea level rise, hurricanes and river flooding. An approach utilising many lines of defence has been adopted, involving structural and non-structural defences. One of the key protection measures is the conservation and restoration of wetlands as a buffer zone between the sea and the city. Detailed actions aimed at the promotion of wetlands are included in the New Orleans Masterplan under the headings of green infrastructure and city resilience. Inclusion of wetland conservation and restoration activities in the New Orleans Masterplan signals a significant change of flood-defence tactics in the region from an emphasis on levees and floodgates to the incorporation of more natural solutions. The focus on wetlands as a natural buffer responds to the calls of research emphasising the importance of wetlands in flood protection.

Case study location

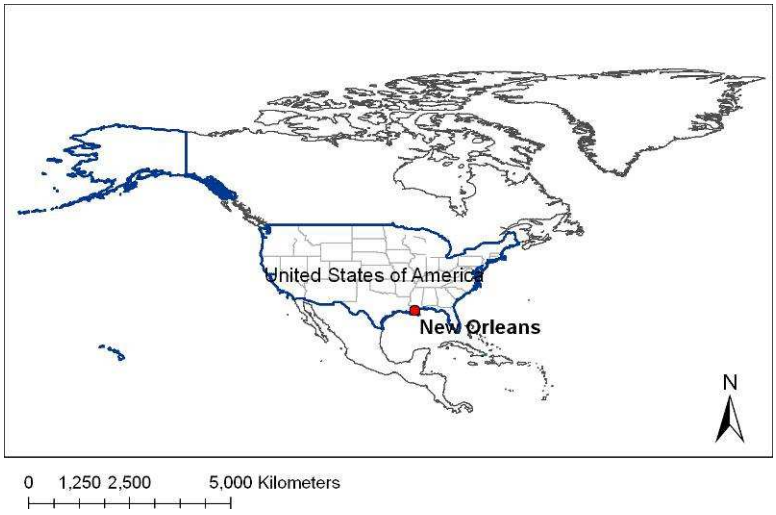

Figure 1. Location of New Orleans in the USA

New Orleans is a major port in the United States, and the largest city and metropolitan area in the state of Louisiana. It is located in southeastern Louisiana, on the Gulf of Mexico. The city straddles the Mississippi River. New Orleans is famous for its cuisine and music – it is the birthplace of jazz. New Orleans currently (2010) is home to about 255,000 people, which is about half of the population in 2005 pre-Hurricane Katrina.

The Gulf of Mexico is characterised by the frequent occurrence of hurricanes. A major hurricane has hit the Gulf Coast every year since 1994, with 26 named storms and 14 hurricanes occurring in 2005[(1)]. According to the Federal Emergency Management Agency, New Orleans is the US's most vulnerable city to hurricanes. The city is at high risk because of its low elevation. Most of its area is currently between 0.6 to 5m below sea level [(2)], and the city is surrounded by water from the north, east and south (Figure 2).

Hurricane Katrina in 2005 had a devastating impact on the city, causing the failure of the levees and floodwalls that protect it and creating the worst civil engineering disaster in American history. As a result of the hurricane, 80% of New Orleans was flooded, and across Louisiana 1,500 people lost their lives, 900,000 people were displaced, 16,000 businesses were flooded and forty schools were destroyed, with majority of the losses and damage occurring in New Orleans itself [3].

Figure 2. Location of New Orleans in relation to Mississippi River and Lake Pontchartrain [4]

Louisiana's coastal zone was formed by sediments deposited during a series of 16 major Mississippi River deltaic episodes that have occurred over the past 7,000 years, which have created a region of coastal wetlands covering over 13,000 km^2 [5]. These wetlands represent 30% of the total coastal wetlands in the US, and at the same time account for 90% of coastal wetland loss nationally [1]. It is estimated that Louisiana has lost more than 3,000 square miles of its coast in the last 70 to 80 years alone, at a rate of nearly 62 km^2/year [6]. This loss is caused by coastal erosion due to levees along the Mississippi River. The levees have prevented some flooding, but also prevent the river from depositing its sediment. This key element of natural coastal land building processes has therefore been severely impaired. Construction of artificial channels for oil and gas drilling and other commercial activities (most notably the Mississippi River Gulf Outlet) also destroyed wetland areas [1], [7]. Hurricanes also damage wetlands. Indeed, around metropolitan New Orleans, where wetlands have historically formed a critical storm surge buffer, the loss of coastal marshes as a result of Hurricane Katrina was so great that it represented about 50 years of projected wetland loss [1].

The climate of New Orleans is humid subtropical (Köppen climate classification *Cfa*), with short, generally mild winters and hot, humid summers. New Orleans has always faced the risk of flooding from three sources: the Mississippi River, heavy rains, and hurricane storm surge, the last of these posing the greatest threat of catastrophic flooding in New Orleans. Global sea level rise and the risk of stronger, more frequent hurricanes as a result of climate change may also be contributing to increased risk [7]. Climate change is projected to increase sea level by 3-10mm per year in the next 50 years. This, combined with the subsidence of the Louisiana's deltaic coast, may amount to sea levels in the Gulf of Mexico being between 60-180cm higher over the next century than they are today [1]. Projecting forward the current land loss rate, by the year 2050 Louisiana will have lost a further one million acres of coastal wetlands. In addition, the sea will continue to advance inland by as much as 33 miles during this period, transforming previously productive wetlands into open water and leaving New Orleans more exposed to sea flooding and hurricanes [1].

However, wetlands play an important role in mitigating the severity of hurricanes. They do this by decreasing the area of open water for wind to form waves, increasing the drag on water motion and hence reducing the amplitude of storm surges, reducing direct wind effect on the water surface, and directly absorbing wave energy. It has been estimated that every 4.3 km of wetlands can absorb one foot of storm surge. This means that a storm tracking from the south of New Orleans could have its surge reduced by 3.66 m if it has crossed 80 km of marsh before reaching the city [(2)]. Hence, protection and restoration of wetlands can be seen as an important adaptation mechanism to the reducing risk of flooding from hurricanes.

Development of the initiative

Key aims

Current plans are to restore as much of the wetlands as quickly as possible. This will involve a combination of restoration of natural delta building, marsh creation from use of dredged material, water control structures, and hard structures (e.g. levees and floodgates). The interior marshes have been prioritized for conservation and restoration because of the ecological services they provide, combined with the storm surge protection they offer to densely populated areas including New Orleans [(1)].

Themes driving the initiative

Adaptation to hurricanes and sea level rise
A major lesson of Hurricane Katrina is that New Orleans cannot simply rely on bigger or better levees, gates, and pumps for flood protection. The city must adopt a strategy that addresses multiple lines of defence (Figure 3), some of which will require continued advocacy and vigilance, and some of which the city and it citizens can take charge of themselves. The multiple lines of defence range from restoration of coastal wetlands, development of hard infrastructure, and non-structural strategies such as land use and building codes, and enhanced emergency preparedness[(7)].

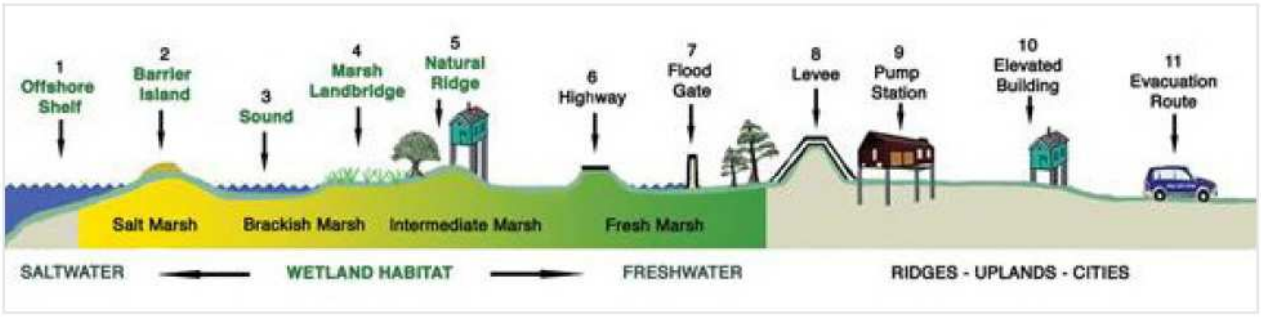

Figure 3. Multiple lines of defence against hurricanes, flooding and sea rise, including wetlands [(7)]

National and state legislation and actions
While the problem of wetland loss was recognised in the 1970s, concerted attempts at restoration did not begin until the 1990s. Initial efforts largely focused on addressing local problem areas, and sought to prevent future losses rather than restore wetlands that had already been lost [(6)]. A more inclusive ecosystem restoration plan, "Coast 2050—Toward a Sustainable Coastal Louisiana", was developed in 1998. This was based on the recognition that the natural geomorphic and ecological processes that had created the coast have been severely impaired, and that the reestablishment of these processes is essential. The plan focused on strategies necessary to achieve a greater degree

of coastal sustainability across the region, which requires (amongst other things) the replacement of lost wetland areas [6].

Following Hurricane Katrina, the importance of coastal wetlands for hurricane protection in Louisiana became more widely acknowledged. In November 2005, the State of Louisiana Legislature created the Coastal Protection and Restoration Authority (CPRA). It was given the mission of coordinating local, state and federal agencies to achieve comprehensive coastal protection and restoration, particularly through integrating activities in two previously separate areas, wetland restoration and flood control. CPRA prepared a master plan for coastal protection and restoration, although much of this concentrated on improvement and installation of coastal levees with floodgates that could diminish the sustainability of the coastal landscape [5]. However, wetland restoration and preservation features prominently in the "Louisiana Speaks Regional Plan" (Figure 4) for recovery after the recent hurricanes [8].

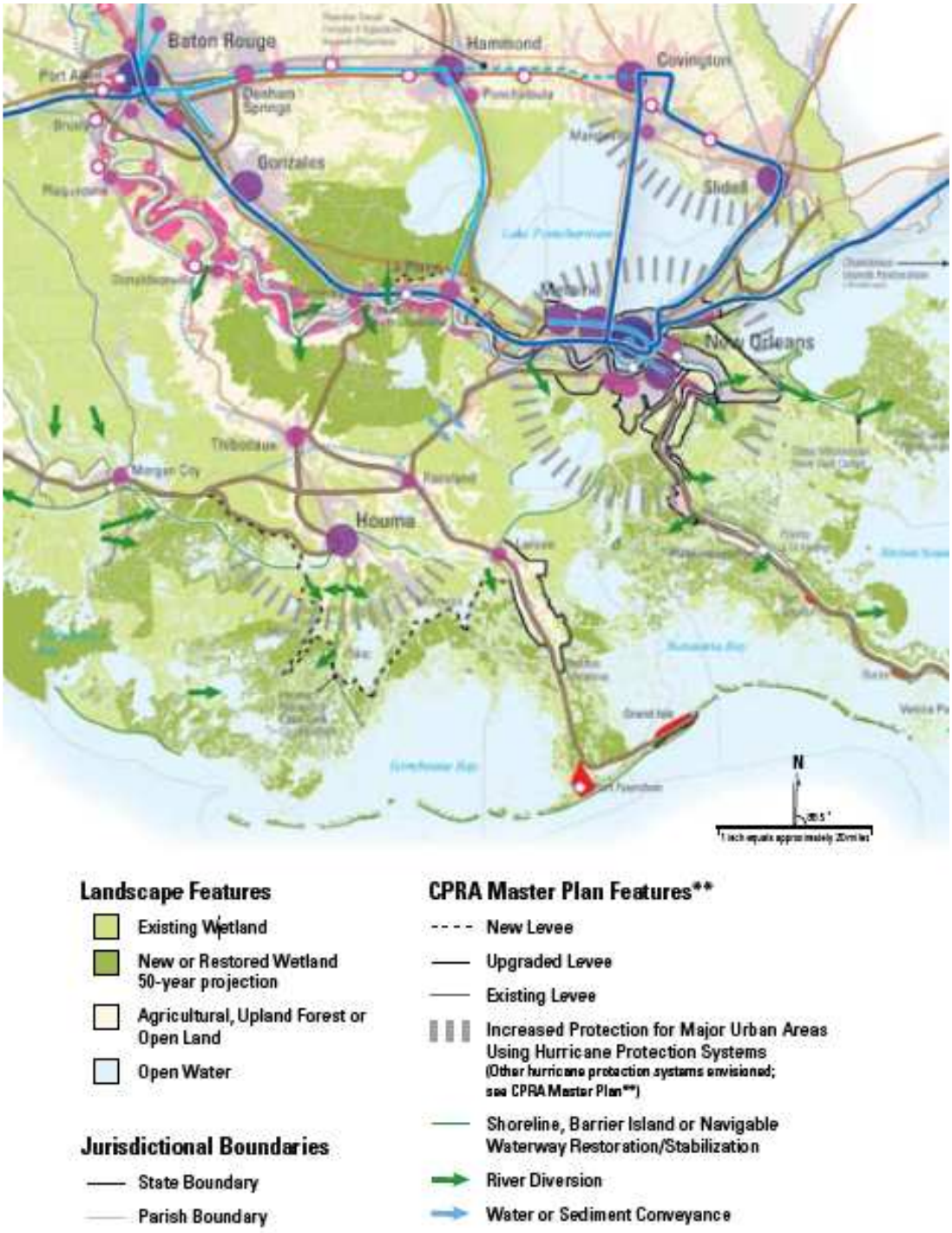

Figure 4. Map presenting planned restoration of wetlands in the "Louisiana Speaks Regional Plan" [8]

Details of the initiative

The need for protection and restoration of wetlands around New Orleans has been included as a feature of the City Masterplan (Plan for the 21st century: New Orleans 2030) produced in January 2010. Wetland conservation is covered explicitly in two chapters: Chapter 7 (Green infrastructure: parks, open space and recreation) and Chapter 12 (Resilience: living with water and natural hazards).

Chapter 7 of the New Orleans Masterplan [7] focuses on green infrastructure issues. The first goal on the list of priorities aimed at the maintenance and enhancement of green infrastructure networks refers to "**protection of remaining wetland areas inside and outside the levee system"**. The related strategies for decision makers are to:

- **Ensure that land use and zoning categories for wetlands and coastal areas promote wetland preservation**: The state of Louisiana does not specifically define wetlands for regulatory purposes, but it does define a coastal zone in which jurisdiction is based on elevation and hydrologic characteristics. Although the entire City of New Orleans is part of the regulated coastal zone, the entire city within the levees is designated as "fastland" for which there is no regulation relating to wetlands. Establishment of a land use category and zoning categories for natural areas within the levees will enhance existing programs aimed at wetland preservation. This will encourage the protection of even isolated wetland areas within the city.

- **Establish regulations and enforcement systems to protect wetlands**. A city wetlands protection ordinance would allow the City to define wetland areas for protection and regulation. This would help to create a system, whereby development activity within a specified distance of wetland areas would have to meet certain requirements. Further, where there is existing development close to wetlands or coastal areas, a regulatory system should ideally be established to review proposals leading to alteration of wetlands with mitigation requirements enforced should the proposal be allowed to proceed.

- **Seek conservation solutions for wetlands through permanent protection or acquisition by conservation organisations**. Natural areas in private hands can be protected through voluntary conservation servitudes (easements). Here the property owner retains title to the property but agrees to permanently give up the development rights on the land. In return they receive a payment through a government programme, or a reduction in taxes on the land. Conservation servitudes such as this are part of the Louisiana Coastal Wetland Reserve Program, which works with farmers to restore lands to wetlands, making a payment for the agricultural development rights in return for establishment of a conservation servitude on the land. Although wetland property owners in New Orleans are not farmers, this program could provide a precedent for how a similar scheme could be administered in the city.

Chapter 12 of the New Orleans Masterplan [7] focuses on "Resilience: living with water and natural hazards". The main goal related to wetlands is to **"expand the coordination and implementation of coastal restoration efforts"** in New Orleans. The actions include measures such as:

- **Improving coordination in coastal restoration matters between the City of New Orleans and other state, local, and federal agencies**. The permitting process for development activity in a wetland or coastal area is extremely complicated. Closer coordination and better defined protocols would lead to more informed decisions and a quicker process for both developers and concerned members of the community.

- **Securing funding for and support the implementation of locally driven coastal restoration efforts**. Wetlands restoration projects have the potential to receive substantial funding as carbon sequestration projects. A "cap and trade" system allowing carbon polluters

to offset their emissions with carbon sequestration or mitigation projects appears to be an imminent possibility in the US. The Obama administration has signalled its strong support for such an initiative by including anticipated revenue streams from a cap and trade system in their 2010 budget proposal. The City should work closely with the Louisiana Coastal Protection and Restoration Authority (CPRA) to identify the specific mechanism by which coastal restoration activities can become eligible in this scheme. This would allow them to be marketed to interested parties, and for local projects of an appropriate scale and cost to be identified and undertaken by local governments.

- With the assistance of the New Orleans Redevelopment Authority (NORA), **facilitate the acquisition of "paper subdivisions"** (subdivisions of small lots that were created prior to modern subdivision regulations and that have never been developed) in undeveloped areas to assemble land for conservation and coastal restoration projects. The Office of Environmental Affairs should work closely with CPRA and the New Orleans Redevelopment Authority to identify critical coastal restoration projects that require the assembly and consolidation of these paper subdivisions. The City could then acquire and land bank these properties in order to facilitate restoration projects in the future.

- Include in the city's GIS property database a legal inventory of property and parcel boundaries outside of the hurricane protection system in Orleans Parish. Determining property ownership outside of the levees is frequently difficult and can as a result be a hindrance to coastal preservation and restoration efforts.

- **Ensure consistency between the CPRA plan, the City's Master Plan, the City's Coastal Management Plan, and the City's land use regulations** in coastal restoration policies, phasing, funding, and recommendations. All of these documents have an important role in guiding how the city's wetlands are managed, protected, and restored and should therefore be integrated.

- **Update the Coastal Management Plan**, which dates from 1985.

- **Create a new local wetlands protection ordinance** that is specific to wetlands and that reflects development constraints and challenges in these areas. While both federal and state agencies can potentially be involved in permitting activities in coastal and wetlands areas, they do not have the power to supersede local land use regulations. Local ordinances, zoning and subdivision regulations represent the first line of defence in protecting the health of New Orleans' wetlands.

- **Create an improved inventory of wetlands in Orleans Parish** to inform land use policies and coastal restoration efforts. This should involve working with state government, the Army Corps of Engineers, and universities in the region to compile an updated inventory and detailed digital maps of wetlands in Orleans Parish.

Implementing the initiative

The New Orleans Masterplan was completed in January 2010. The development of the document started in 2008, and involved an extensive public consultation process. The implementation of the Masterplan has been designed around a series of actions with clearly assigned responsibilities, time scales and resources (Table 1).

Table 1. Implementation schedule of the New Orleans Masterplan [7]

Strategies	Actions			
	How	Who	When	Resources
Ensure that land use and zoning categories for wetlands and coastal areas promote wetland preservation.	Include in the new Comprehensive Zoning Ordinance	City Planning Commission	2010-2014	Comprehensive Zoning Ordinance rewrite contract
Establish regulations and enforcement systems to protect wetlands.	Enact a City wetlands-protection ordinance defining wetlands, prohibiting drainage of wetlands, and regulating impacts within a defined distance of wetlands.	Environmental Affairs; City Attorney; City Council	2010-2014	Staff time
Seek conservation solutions for wetlands through permanent protection or acquisition by conservation organisations	Discuss options with environmental organisations	Environmental Affairs; Trust for Public Land	2015-2019	Staff time; federal or non-profit funding
Expand the coordination and implementation of coastal restoration efforts in Orleans Parish	Streamline policy coordination and wetlands permitting among the state, ACE and local government	Environmental Affairs	2010-2014	Staff time
	Update the Coastal Management Plan	Environmental Affairs	2010-2014	Federal, state or non-profit funds
	Explore the potential of funding local wetlands protection and restoration projects	Environmental Affairs	2010-2014	Staff time
	Ensure consistency between the CPRA plan, the Bayou Sauvage Master Plan, the City's Master Plan and land use regulation	City Planning Commission, Louisiana Coastal Protection and Restoration Authority; Environmental Affairs	2010-2014	Staff time
	Create a local wetlands protection ordinance	Environmental Affairs, City Council	2010-2014	Staff time
	Create an improved inventory of wetlands in Orleans Parish to inform land use policies and coastal restoration efforts	Environmental affairs	2010-2014	Staff time; state capital restoration funds
	Resolve any property and subdivision issues in areas outside the levees through a property inventory and acquisition of paper subdivisions	Environmental Affairs; Office of Technology; City Planning Commission; New Orleans Redevelopment Authority	2015-2019	State coastal restoration funds

The implementation of the plan will involve several challenges. These include raising public awareness about related issues including the realities of environmental hazards and their probability / risk, the use of wetland mitigation options after 40 years of reliance on levees, and securing adequate funding on an accelerated basis for further coastal restoration efforts [7]. Systematic planning interventions in coastal Louisiana are further complicated by mismatches between the natural boundaries of the problem and the scales at which regulatory and planning authorities operate. For example, New Orleans as a municipal land use authority has planning and regulatory jurisdiction over only a small fraction of the coastal area. Further, the official regional planning commission created by the Louisiana legislature for the five parishes around New Orleans has no regulatory authority. Also, it does not have sufficient geographic coverage to deliver effective coastal ecosystem planning in the area [1]. This requires collaboration with state and national bodies [7], including the Louisiana Office of Coastal Protection and Restoration (OCPR), Louisiana Recovery Agency, Federal Emergency Management Agency (FEMA), and the U.S. Environmental Protection Agency. The U.S. Army Corps of Engineers are also important

stakeholders. They are well positioned to maintain and protect the coastal system at a larger scale and to regulate activities that impact coastal waters and wetlands, although they may not have the mandate to intervene in land use matters involving private property. Furthermore, the U.S. Army Corps of Engineers still favour structural 'hard infrastructure' measures such as levees and pumps to coastal management issues [(1)], which may jeopardise plans to restore coastal wetlands [(2)].

Building the evidence base

A study carried out in 2009 reported that upstream dams and reservoirs result in only half the sediment necessary to create coastal marshes reaching the delta area in comparison to 100 years ago and unless Louisiana launches major projects within the decade, coastal erosion will advance so rapidly that it will reach a point where there is no realistic way to stop it. It was also stated that sea levels are rising at three times the rate of 100 years ago [(7)]. This study, in addition to the damage caused by Hurricane Katrina and in conjunction with the national USA climate projections, has provided a wake-up call for decision-makers in New Orleans.

Monitoring and evaluation

No specific targets have been set in the Masterplan regarding monitoring the restoration of wetlands.

Sources of funding

Table 1 highlights the resources needed to complete the actions, and indicates funding sources required. The Gulf of Mexico Energy Security Act, signed into law in December 2006, gives Louisiana and other Gulf Coast states 37% of the revenues from newly opened oil and gas tracts. Louisiana has constitutionally dedicated all these revenues to coastal restoration and protection. Along with other anticipated revenue streams, this could provide approximately $1 billion per year over the next 30 years for these purposes [(5)]. Additional funding measures include the dedication of recent state surplus funds to coastal restoration projects, the creation of the federal Coastal Impact Assistance Program of 2005, and the inclusion of $1 to 2 billion for coastal restoration in the 2007 federal Water Resources Development Act (WRDA). These funding sources are supporting a wide variety of coastal restoration initiatives, such as freshwater diversion projects that direct Mississippi River sediment to rebuild marshlands. Estimates of the total cost of coastal restoration in Louisiana run as high as $45 billion [(7)].

Stakeholder engagement

Collaboration with key stakeholders

The lead authority on development of the Masterplan was the City of New Orleans. The approval of the Masterplan by the City Planning Commission and the City Council provided the political engagement and support. The development of the Masterplan was based on existing regulations and legislation developed by national and state level bodies including the Louisiana Office of Coastal Protection and Restoration (OCPR), Louisiana Recovery Agency, Federal Emergency Management Agency (FEMA), the U.S. Environmental Protection Agency, and the U.S. Army Corps of Engineers. Collaboration with these bodies is crucial for the development and implementation of the Masterplan.

Engaging the public

The Masterplan outlines the strategy for community participation during its development. The crucial elements of this community participation process include:

- A sounding board consisting of a diverse group of New Orleans' population was invited by the City Planning Commission to engage in the planning and zoning process. Due to public interest, this was later structured as an open group enabling other community members to join.
- Groups of knowledgeable people from the public, private and non-profit sectors, including neighbourhood representatives, were invited by the City Planning Commission to work on specific master plan and zoning topics.
- The Masterplan and Comprehensive Zoning Ordinance website was used to make announcements about upcoming public events relating to the plan, as well as to share the results of meetings with the public.
- Press and media were notified of key developments in the Masterplan process. Local news media highlighted several planning events and issues in print and online publications. Other media used to distribute information about the Masterplan included newsletters, event flyers, TV and radio announcements.
- The opinions of residents were gathered through interviews and focus groups, citywide forums and district meetings.
- The draft Masterplan was made available for public review and feedback on the project website, in libraries and other public locations in March 2009 (first version) and September 2009 (second version).

Can it have an impact?

The focus on restoration of wetlands in New Orleans signals a significant change in thinking about protection from flooding, sea level rise and hurricanes in Louisiana. There is a clear shift in emphasis from structural defences to more natural solutions utilising green and blue infrastructure. This is based and was inspired by the Dutch experiences and their strategy of making room for water (see the Netherlands case study). However, the wetland restoration efforts are currently at a policy rather than implementation stage, and the implementation phase is likely to be faced with many challenges (as discussed above).

In addition, the Office of Environmental Affairs in the City of New Orleans is responsible for implementing the 1985 New Orleans Coastal Management Plan, oversight of wetlands restoration and coordination with other agencies. However, this Office has limited capacity to review development proposals, which may have implications for effective protection of wetlands. Moreover, the Army Corps of Engineers' and the state Department of Natural Resources' criteria for permitting small developments in wetlands areas do not take into account the potential effects of cumulative small scale actions [(7)].

The scale of the coastal restoration required poses a major challenge to science and science-based planning to develop the most strategic and effective strategies. These strategies must also minimize the conflicts and maximizing the synergies concerning achieving multiple social objectives within a sustainable coastal landscape. At the same time, substantial uncertainties must be recognized, accepted, and incrementally reduced through a long-term adaptive management approach that promote learning and effective decision-making. This will require substantial improvements in science, engineering, planning, and management capacity, all operating with a sense of urgency and purpose [(5)].

Significant funds have been appropriated to implement coastal restoration and urban mitigation projects, but more is required [(7)]. The recent escalating costs of restoration and levee protection along with the decline in the price of domestic oil & gas revenue from Louisiana (which reduces the State's ability to generate matching revenue for coastal restoration and protection projects), is

currently hindering the implementation of the coastal plan. Even with adequate funding and access to land, the construction of more robust levees and wetlands will likely take at least a generation to implement [(1)].

A future opportunity for supporting the restoration of wetlands may lie in climate change policy because of wetland's exceptional role as "carbon sinks." With the establishment of a cap and trade system of carbon credits, the New Orleans wetlands will become valuable as sources of carbon credits because they act as excellent vehicles for carbon sequestration [(7)].

Key messages

- The New Orleans Masterplan provides an example of a strategy aimed at increasing the resilience of the city to climate change and associated extreme weather events. Green and blue infrastructure is identified as one of the measures of increasing resilience to hurricanes and floods

- The detailed implementation plan outlines the necessary collaboration, resources and timescale required for every action.

- The New Orleans Masterplan openly acknowledges learning from experiences of The Netherlands in learning to live with water rather than trying to stop it.

Contact organisation

City of New Orleans Planning Team and Goody Clancy (the team leading the Master Plan / Comprehensive Zoning Ordinance consultant team): nolamasterplan@goodyclancy.com

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[(4)] http://en.wikipedia.org/wiki/File:New_Orleans_Elevations.jpg

[(5)] Day J.W. Jr., Boesch, D.F., Clairain, E.J., Kemp, G.P., Laska, S.B., Mitsch, W.J., Orth, K., Mashriqui, H., Reed, D.J., Shabman, L., Simenstad, C.A., Streever, B.J., Twilley, R.R., Watson, C.C., Wells, J.T., Whigham, D.F. (2007) Restoration of the Mississippi delta: lessons from Hurricanes Katrina and Rita. Science 315: 1679 – 1684.

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Faenza: Extra cubature for developers in return for green space

Climate change impacts addressed	High temperatures
Spatial scale	Town or city
Response type	Regulations Incentive scheme
Core drivers	Response to current climate Mitigation of climate change Quality of life and attractiveness of place Development need despite climate impacts
Factors of success	Cohesive delivery of multiple benefits Public engagement

Summary

The Municipality of Faenza has implemented a bio-neighbourhood incentive programme for developers. This is included in their Town Planning Regulations. The incentive programme aims to achieve energy savings, promote aesthetic qualities of neighbourhoods, and also create better microclimate conditions to prepare for future rising temperatures associated with climate change. The incentive programme allows developers to extend the cubature of buildings in bio-neighbourhoods in excess of approved standards, if the buildings meet certain criteria of environmental sustainability. These include green roofs, green walls and water retention systems, and also the creation of continuous public green spaces by developers. The unique characteristic of the regulations is that there are no set standards, with the development conditions negotiated on case-by-case basis. The negotiations between town authorities and developers or housing associations significantly shorten the wait for building permits to be obtained therefore providing an incentive to engage in the scheme, and in addition engage a wider range of stakeholders into the town planning process.

Case study location

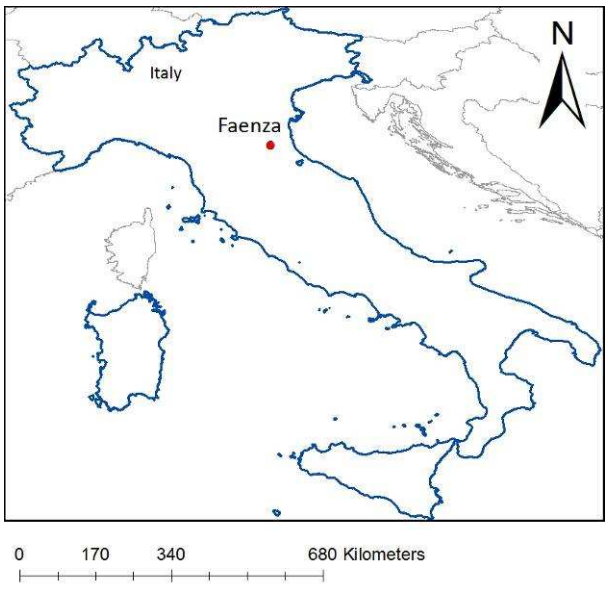

Figure 1. Location of Faenza

Faenza is an Italian city in the province of Ravenna, Emilia Romagna, situated 50 km southeast of Bologna. Faenza has nearly 58,000 residents and population density is 267 people/km^2. The town is located at the foot of Subapennine hills and is surrounded by vineyards and orchards. In the nearby green valleys of the rivers Samoggia and Lamone there are great number of 18th and 19th century stately homes, set in extensive grounds or preceded by long cypress-lined driveways. Faenza is noted for its manufacture of majolica ware glazed earthenware pottery, known from the name of the town as "faience".

The location is characterized by temperate climate with hot and humid summers with little rainfall. Winters are rather cold. The future climate projecttions estimate the increase of maximum summer temperatures by between 3.9ºC (B2 climate change scenario, or medium CO_2 emissions) and 5.5ºC (A2 scenario, or medium-high emissions).

Development of the initiative

Key aims

The main aim of the bio-neighbourhood incentive programme include within the Town Planning Regulations in Faenza is to incentivise developers (including housing associations set up by residents) to construct buildings. The programme encourages these buildings to be sustainable, utilizing appropriate materials and implementing energy-saving and water-saving measures for example. The aim is also to situate the buildings in a way that allows a continuous area of green space to be maintained. Therefore, the objectives of the initiative range from issues including climate change adaptation, energy saving and improving urban quality.

Themes driving the initiatives

Key issues taken into account in the preparation of the 1999 Town Planning Regulations, which include the bio-neighbourhood incentive programme, are protection of the historic and natural features of the area, protection of archeological sites, protection and creation of open space, promoting consistency of building types, and enhancing the well-being of the citizens.

Inclusion of the rules on bio-neighbourhoods in the Town Planning Regulations was specifically driven by the need to create beautiful, livable, and low-energy neighborhoods to improve the quality of life of people living in Faenza.

The prior mechanisms that have set a framework for the bio-neighbourhoods programme include:

- **Engagement of Faenza residents in environmental issues** linked to economic development.
  - "Faenza 2010 - The City We Want", an awareness raising campaign that started in 1998;
  - Awarding "Blue stickers" for cars and heating systems, which highlights the adherence to fuel- and energy-use standards;
  - "City Center by bike" transport initiative.

- **Local Agenda 21:** In 1999, the Municipality of Faenza joined the national project "Agenda 21" for urban areas: a pilot initiative involving some small-medium sized cities in Italy. This helped to promote development rules and practices based on the direct involvement of developers and citizens in the urban design process.

- **Focus on green spaces:** During the preparation of the 1999 Town Planning Regulations, Faenza approved a new "Municipal Rule of Green", which emphasizes the role of green spaces in the improvement of urban quality.

Details of the initiative

The Town Planning Regulations 1999 (*Piano Regolatore Generale*) introduced an incentive scheme for developers to incorporate sustainable practices in building design. This approach was confirmed and extended by the Municipal Structural Plan in 2009. The incentive scheme utilizes the principle of "transfer of development rights" (*perequazione urbanistica*). At the design stage, the developer is allowed to extend the cubature of buildings (both the number of floors and the size of the buildings), or include more use types (residential, commercial, or industrial etc), if the development is characterized by certain criteria relating to environmental sustainability and aesthetic quality.

To qualify for the incentive scheme, new developments need to meet the following four main criteria:

1. Full utilization of space inside dwellings.
2. Soundproofing of buildings and indoor areas.
3. Maximising ground permeability and water retention is encouraged utilizing measures such as water metering, use of technical devices reducing the waste of water and re-use of grey water. Systems of rainwater collection, filtering and storage are also promoted.
4. Creation of green areas and appropriate landscaping of the external environment. This includes promoting high quality design of courtyards and communal areas.

In addition, in order for the developer to benefit from increasing the building's size and variety of permitted uses, the green building criteria must be followed. These criteria are listed in the "Rules for the implementation of incentives to green building measures", which were developed by professional engineers of the Building Commission of the Faenza Municipality (Box 1). It is also significant that if the development incorporates existing buildings, these must also be up-graded and reorganized to secure the sustainability of the entire project.

Box 1.The green building criteria

- Spatial orientation: the buildings should have large windows facing south-east and west
- Promote use of natural and environmentally friendly materials
- Avoid sources of pollution (including electromagnetic and acoustic pollution)
- Promote natural ventilation
- Use electrical systems which limit alteration of natural electromagnetic field
- Use low-energy, low-emission and efficient heating systems
- Use rainwater-recovery systems and use rainwater for watering plants
- Green spaces should be arranged in a way that provides shading and cooling, as well as screening of wind and noise. Appropriate tree species should be selected.
- Take into account local context, e.g. the environment, architecture and building types

Furthermore, developers may create buildings of a larger volume if they minimize land consumption by concentrating the development in one part of the plot of land. This then leaves the remaining land as open, public space, therefore improving urban quality and providing cooling and shade. The required expansion of green space depends on the context of the development (Figure 2). In urban areas less green space is required for a development to qualify for the incentives, whilst in peri-urban areas the greater availability of land means that the developer is required to commit a proportionally larger part of the total plot to green space (Figure 3).

Figure 2. Examples of green/permeable space landscaping and buildings in the bio-neighbourhoods

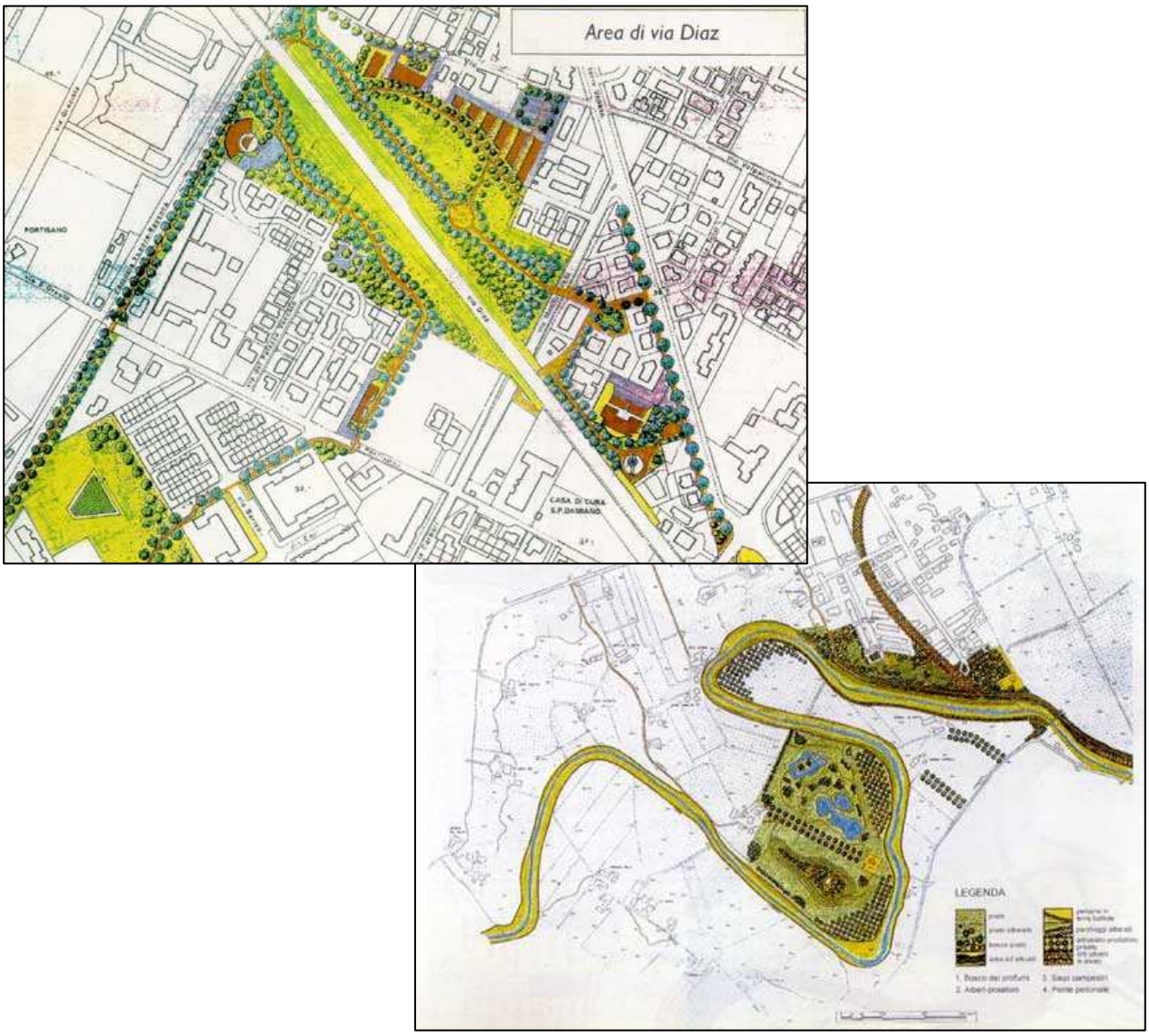

Figure 3. Examples of bio-neighbourhoods in Faenza. Developers received permission to extend the size of a group of buildings. In exchange, the buildings had to be clustered in the north of the site in order to minimize the use of land, and to create a large, continuous green space that can provide shading and cooling.

Implementing the initiative

In order to receive the incentive, i.e. the permission to construct larger buildings, the developer needs to provide the Municipality of Faenza with documentation describing the design of the project. This includes:

1. Analysis of the immediate building development context and the surrounding environment
2. Building plans and description of the infrastructure and building materials.

The developer needs to present at least three different proposals of development of the site (such as one presented in Figure 4).

This documentation is checked for compliance with the green building criteria list. Therefore, the "transfer of development rights" is carried out on a case-by-case basis, and involves considerable flexibility according to the particular circumstances of the development. There are no set standards (such as traditional building standards), and the decision is made based on the performance of each particular building and the plot within which it sits.

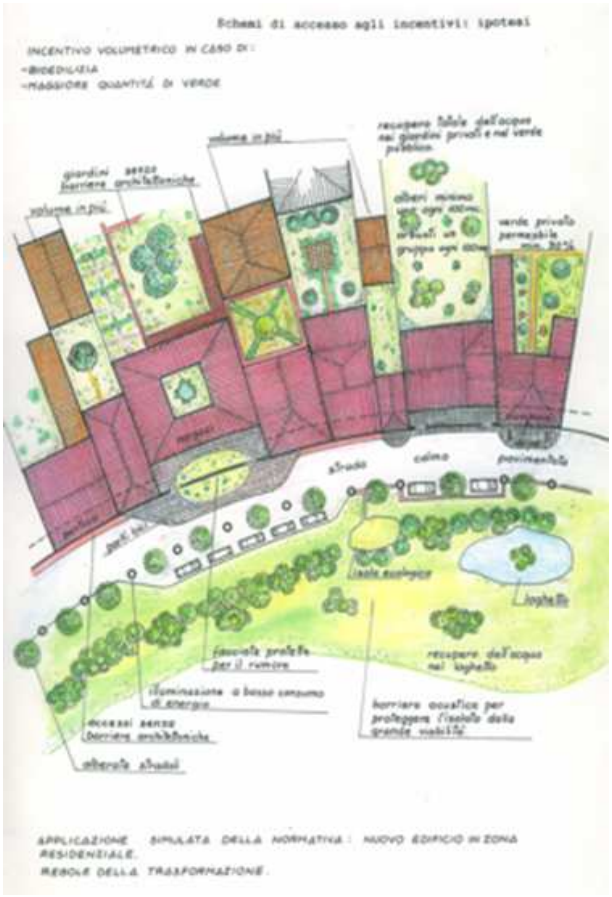

Figure 4. Example of a development proposal

Monitoring and evaluation

Municipal Administration of Faenza has the power to assess, upon completion of the development project, whether the developer has actually followed the approved design of the plan, based on criteria included in "Rules for the implementation of incentives to green building measures" (see Box 1).

Stakeholder engagement

The municipal administration of Faenza was the leading actor in the development of the initiative. The full support and political buy-in of the Municipality in implementing the bio-neighbourhood incentive scheme in the TOWN PLANNING REGULATIONS was an important factor in promoting the sustainability of development activities as a priority issue. Other main stakeholders are the developers, or groups of individual citizens, who want to construct a bio-neighbourhood. The nature of the regulations enables stakeholders to be involved in negotiations on the design of buildings and bio-neighbourhoods, and consequently become engaged in the town planning process. The role of citizens is fundamental to the town planning process in Faenza, and their engagement is essential to secure new continuous green spaces and the improvement of overall environmental and aesthetic quality in the municipality

Sources of funding

The project was funded by Municipal and Regional Funds.

Can it have an impact?

Due to its inclusion in Town Planning Regulations, the bio-neighbourhood initiative covers the whole territory of the Municipality of Faenza. As of 2010, two bio-neighbourhoods have been developed including a total of 500 apartments in 250 private property units. However, now that they are established, measures such as the green building criteria, requirements for permeable surfaces and rainwater recovery, and requirement for reduction of noise pollution, may be applied to all developments within the municipality.

The most important aspect of this initiative is its inclusion in the Town Planning Regulations. The Faenza bio-neighbourhoods approach represents a true environmental planning initiative, where the regulations go beyond a focus on traditional economic goals and are instead based on urban sustainability achieved through flexible rules and cooperation with citizens.

The emergent green areas together form a "green system", which links the town with the countryside, providing space for recreation and biodiversity functions (see also the case study of

Mirandola, Appendix 1). Due to the improvement in town quality, the population of Faenza has grown by 6%.

The lack of set standards encourages developers to search for and implement innovative solutions to the design of the buildings and the surrounding area. Furthermore, the negotiations between the developers and the municipality based around flexible rules are less time consuming than the process of checking adherence to rigid building standards. Reduced time of obtaining building permits (thanks to the participative character of town planning process) encourages developers to invest in Faenza. Similar incentive systems are now being used in other municipalities in the region (see short case study of Mirandola).

The Town Planning Regulations in Faenza have received a wide recognition and a number of awards, both nationally and internationally:

- First prize in National ENEA (National Agency for New Technologies, Energy and Environment) 1999 scheme for the innovative approach of their Town Planning Regulations.
- Faenza was among six urban plans that the UK Royal Town Planning Institute chose to present at the Johannesburg World Summit on Sustainable Development (2002) as exemplary examples.
- The Municipality of Faenza (RA) received a European Prize for Urban and Regional Planning (Challenges 2009) for environmental protection, the consideration and promotion of energy and environmental sustainability, the application of bio-climatic techniques, the adoption of flexible procedures, and the innovative incentive system.

Key messages

- The use of flexible rules in Town Planning Regulations to promote sustainable development can be as efficient as rigid standards;
- The participative character of the process means that the details of the development are negotiated, what can save time and resources for both the developer and the municipality;
- The use of an innovative approach in Town Planning Regulations means that the municipality of Faenza is now recognized in Italy and in Europe for high quality planning and the example is followed by other municipalities in the region;
- Agreements with individual developers can lead to the creation of continuous green spaces in areas where land is privately owned;
- While the Town Planning Regulations were driven by energy efficiency, aesthetic qualities and quality of life, they are likely to bring climate change adaptation benefits in terms of reducing the impact of high temperatures and lessening flood risk.

Resources

http://www.edilia2000.it/633d3526613d3226703d333837312c6e6577732631313d3126353d34/più-sostenibilità-prg-faenza.html
http://www.urbanisti.it/old/consiglioeuropeo-n/Articolo_Premio_IT.htm
http://g5.ambra.unibo.it/portale/documents/Comunicazione/home_comunicazione.php?id_page=204
http://g5.ambra.unibo.it/portale/documents/Comunicazione/home_comunicazione.php?id_page=504
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http://www.comunefinale.net/download/regolamento_verde.pdf

Acknowledgements

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Dorset: Financial contributions of planning applications to prevent heathland fires

Climate change impacts addressed	Fires
Spatial scale	Sub region
Type of adaptation action	Regulations
Core drivers	Biodiversity conservation Development need despite climate impacts
Factors of success	External collaboration Innovative funding mechanisms

Summary

The Dorset Heathlands cover an extensive area of South East Dorset, England, and are fragmented by urban development and other land uses. Heathlands are an important habitat and are protected by European-level designations. They are prone to fires, and this risk is likely to increase with climate change, causing habitat loss and putting the fire rescue service under considerable pressure. Development nearby protected sites significantly increases the risk of fires and other negative impacts on the heath such as loss of biodiversity. With these issues in mind, a Joint Interim Planning Framework was agreed in 2007 by South East Dorset local authorities to cover all protected heathland across South East Dorset. It seeks to secure developer contributions toward funding the implementation of a package of mitigation measures to offset the adverse effects of additional residential development on the heathlands. The framework applies to all new housing that results in a net gain in dwelling units within a zone between 400m and 5km of designated European wildlife sites, and no development is permitted within a 400m buffer around heathland sites.

Case study location

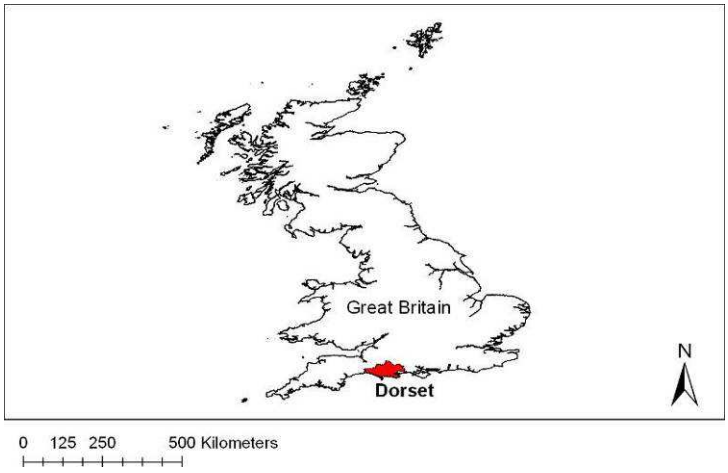

Figure 1. Location of Dorset in England

Dorset is a county in South West England on the English Channel Coast. It covers 2,653 km^2 and is home to 700,000 people. Dorset is largely rural with many small villages, few large towns, no cities and no motorways. The largest urban area is the South East Dorset conurbation which consists of the seaside resort of Bournemouth, the historic port of Poole, the town of Christchurch plus many villages.

The Dorset heathlands are found in the local authority areas of Bournemouth, Christchurch, East Dorset, Poole, Purbeck and West Dorset in the County of Dorset, South England (Figure 1). Heathlands are areas of open landscape dominated by low growing dwarf shrubs (mainly Heather family, *Ericaceae*), and also include areas of acidic grassland, scrub, scattered trees, bog and open water. In Dorset this vegetation developed in a cool, moist climate on nutrient deficient, acid soils as a result of man's removal of the natural tree cover for agriculture in Bronze Age (1000 BC). From its formation until the late 19th Century, the heath was

exploited by man for grazing by horses and cattle, as a source of fuel, and for extraction of underlying sand and clay. Since 18th century the heathland area in Dorset has declined – from 36,000ha to 6,000 ha due to the use of heathland for agriculture, planting of pine trees and expansion of towns.

Heather is highly flammable. Fires are easily started by discarded cigarettes or camp fires, and deliberate arson is also common. Urban heaths (those in the vicinity of urban development) tend to catch fire more frequently than the more rural locations [(1)]. Around 30% of Dorset heathlands are situated within and around the urban areas of south east Dorset, with nearly half a million people living nearby (Figure 2). Consequently, a large proportion of heathlands are extremely exposed to negative impacts of fires, trampling, dog disturbance etc as a result of being used for recreation by this substantial human population [(2)].

Figure 2. Example of urban heathlands – heath areas that have been surrounded by urban development [(3)]

The climate of Dorset has warm summers and mild winters, due to its southern location but also because it is sheltered from the westerly winds. The temperatures are higher than in the rest of the UK (4.5-8.7°C in winter and 19.1-22.2°C in summer). The southern and eastern coastal areas receive as little as 741 mm (29.2 in) per year, while the Dorset Downs receive 1061-1290 mm [(4)].

Climate change scenarios indicate that by 2080, average summer temperatures will have increased by between 1°C and 5°C, and rainfall will have decreased by 20-50% [(5)]. Warmer, drier summers suggest a potentially significant increase in the number of outdoor fires [(6)]. Indeed, between 1995 and 2004 there were 860,263 outdoor fire incidents defined as wildfires in the UK [(7)]. For a 1°C increase in future temperatures, a 17-28% increase in the number of outdoor fires in England and Wales is predicted, and for a 2°C increase between 34-56% more fires are predicted to occur annually. The increase in outdoor fires in the exceptionally warm year 1995 (a temperature higher than average by +3.5°C) was 54% in relation to the 1994 figure [(8)]. Climate change clearly poses a real threat in terms of increasing the incidence of heathland fires in Dorset.

Development of the initiative

Key aims

The Interim Planning Framework developed by a number of local authorities (municipalities) in Dorset, following the guidance of Natural England (the national nature conservation agency for

England and Wales), sets out an approach to the mitigation of the harmful effects of residential development on Dorset's lowland heaths. The approach aims to ensure that the integrity of the heathlands is not further eroded or diminished by a steady increase in urban pressures due to additional development [9]. A range of measures have been identified jointly by the local authorities and Natural England. These include improvement and development of alternative recreational areas to divert recreation from the most sensitive heathland; access management; increasing the number of wardens and education programmes [3]. The mitigation measures are to be financed by developer contributions coming from new developments located in a distance between 400m and 5km away from the protected heathland sites. This will help to reconcile the pressures associated with further residential development in this zone with the conservation of the designated heathland sites [9].

Themes driving the initiative

Urban pressures on heathland

In recent years research has demonstrated that there is a connection between adverse impacts on Dorset heathland, proximity of developed land, and the amount of development on adjacent land [9]. In particular fires on heathland sites tend to increase in frequency where the proportion of adjacent land that is developed is higher. This is due to more intense use by people and accidental or purposeful fires (arson). Also fires are most frequent between April and August when they are likely to cause most damage to heathland vegetation and wildlife [9]. Whilst wild fires in the UK are rarely a threat to life or property (as opposed to e.g. Australia or California), they cause significant environmental damage and require involvement of fire fighting resources that could be needed elsewhere [6].

Other types of pressures on heathland from neighbouring settlements include:

- Trampling of vegetation and habitats
- Off road cycling and motorcycling
- Dumping of waste, dog fouling etc. leading to habitat degradation
- Dog walking and disturbance to ground-nesting birds
- Disruption to hydrology of wet heaths
- Predation by domestic cats [10].

International, European and national nature conservation designations

The Dorset heathlands qualify for three European designations (Figure 3):

- Special Protection Areas (SPAs) under the EU Birds Directive;
- Candidate Special Areas of Nature Conservation (SACs) under the EU Habitats Directive.
- Ramsar sites (an international designation) by virtue of supporting certain wetland bird habitats and species [1].

The international nature conservation designations cover 96% of the Dorset heathland, and 97% is covered by the Sites of Special Scientific Interest (SSSIs) UK designation [12]. SSSIs protect areas important for nature conservation under the Wildlife and Countryside Act legislation [1]. Following these designations, regulation 48 of the UK Conservation (Natural Habitats, &c.) Regulations (1994) require that any application for development or strategic plan which is likely to significantly affect a European site is subject to an appropriate assessment of the implications of the proposal for the site's conservation objectives. The planning authority must ascertain that the plan or project will not have an adverse effect on the integrity of the site, alone or in combination with other plans or projects, either directly or indirectly, taking account of any conditions or restrictions that would help ensure no adverse effect, before granting permission or adopting a plan or policy [11].

It was observed by the UK Government in response to the recommendations made by the Convention on the Conservation of European Wildlife and Natural Habitats Standing Committee on

the conservation of heathlands in Dorset that there is a limited potential to protect the heathland by establishment of buffer zones [12]. This is due to the proximity of existing infrastructure to these zones, and the potentially very costly and extensive demolition and relocation programmes that would need to take place. Therefore, it is apparent that the pressures on urban heathlands need to be addressed in a different manner.

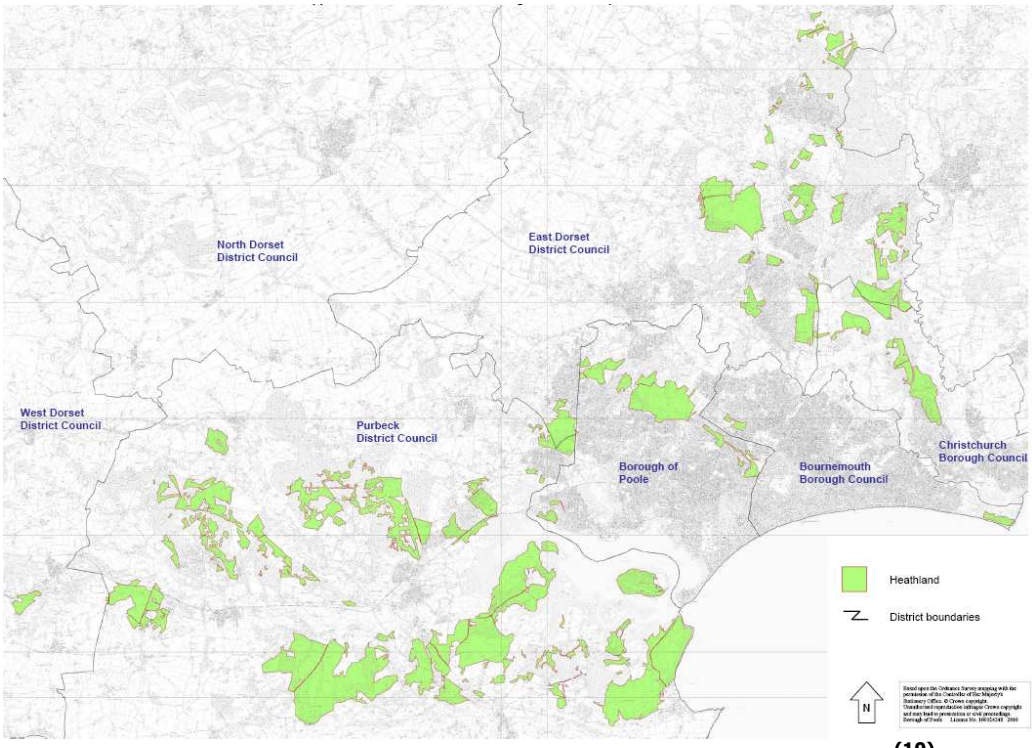

Figure 3. Dorset heathland designated as European Wildlife Sites [10]

Natural England's position on development in proximity to heathland

Various studies have found that public access to lowland heathland, from nearby development, has led not only to an increase in wild fires, but also to damaging recreational uses, the introduction of incompatible plant and animal species, loss of vegetation, soil erosion and disturbance by humans and their pets (amongst other factors). Therefore, Natural England is against any additional development within 400m of heathland. In the area between 400m and 5 km, measured as a straight line from the boundary of protected heath, significant adverse effects still occur. However, in these areas, mitigation measures can allow development proposals to be approved. Mitigation encompasses measures to divert recreational pressure away from heathland, access management measures and securing resources to enable such measures to be implemented. It is in the area between 400m and 5km from protected heaths that the Interim Planning Framework applies [11].

History of partnership approach to protection of heathland in Dorset

The heathlands in urbanised Dorset have a history of protection through partnership approaches. Dorset Heathland Forum was first established in 1989. Then Urban Heaths Partnership was established with the focus on the conservation and maintenance of heathland located close to human settlements, with a particular focus on management of access. The partnership includes local authorities, Dorset County Council (partnership leader), Dorset Wildlife Trust, Dorset Fire & Rescue Service, Dorset Police, Natural England (then called English Nature), The Herpetological Conservation Trust, Forestry Commission, Royal Society for the Protection of Birds and the National Trust.

The Urban Heaths Partnership successfully applied for £1.2 million funding from the European Union LIFE-Nature fund (L'Instrument Financier pour l'Environnement, which translates as 'The

Financial Instrument for the Environment), which was matched by the members of the partnership. The four-year Urban Heaths LIFE Project, was launched in July 2001 to work on 49 separate urban heathland sites in south east Dorset. The project successfully addressed urban pressures on the heaths by providing extra wardens, new fire fighting equipment for Dorset Fire and Rescue Service, a Heathland and Wildlife Protection Officer in Dorset Police and delivering an education programme within the local community and its schools. Since the end of the LIFE Project, permanent staff has been employed in key roles such as Partnership Manager, Education Officer, Senior Warden and Area Wardens, and Seasonal Wardens are employed during the peak fire season (March-September) [(2)].

Details of the initiative

The Interim Planning Framework sets out the approach that, together, the local authorities in South East Dorset will implement an approach to mitigate urban pressures (including fire risk) on heathlands in south east Dorset [(11)]. Firstly, in order to protect the heathland from direct urban influence, under the Interim Planning Framework no additional development will be permitted within 400m straight distance from protected heathland sites (Figure 4). However, development can take place if the applicant contributes to the mitigation approach set out in the Framework in accordance with the levels and procedures for this contribution [(9)].

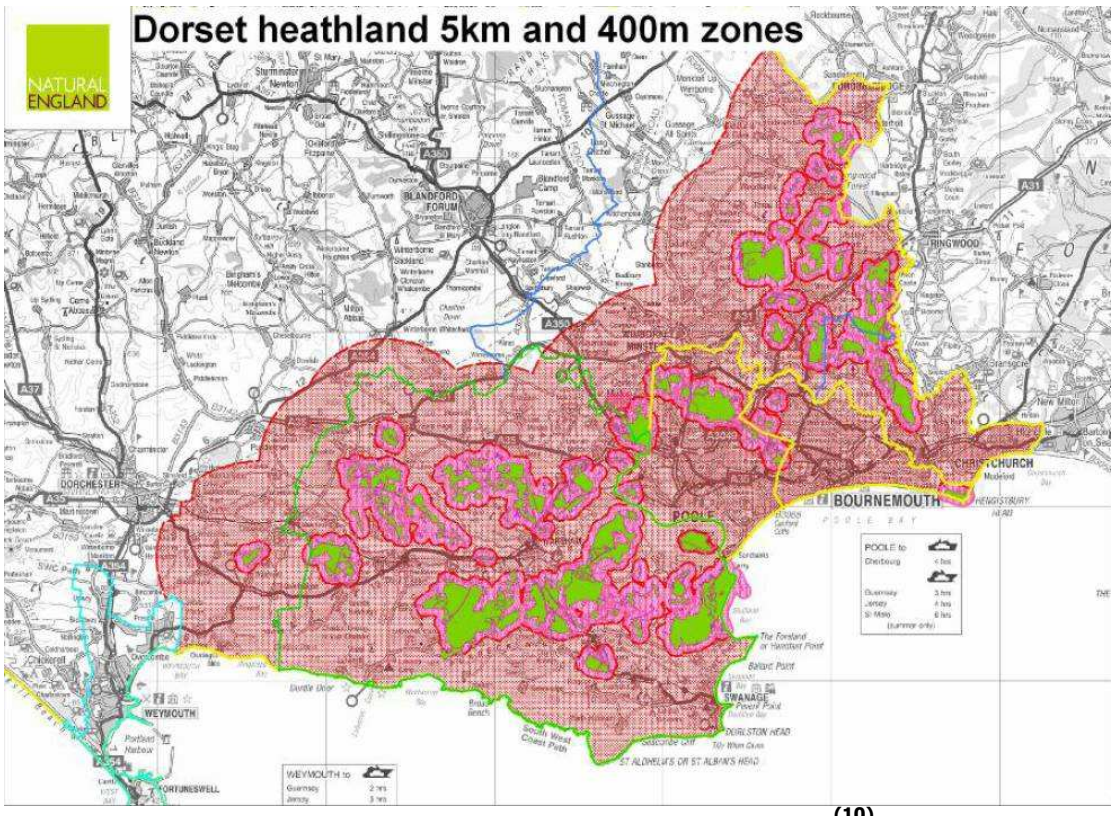

Figure 4. Dorset heathland 5km and 400m zones [(10)]

Secondly, a number of measures will be applied to mitigate the impact of urban development on heathlands. These include:

- Improvement of existing recreational sites (e.g. better access, signage, better surface facilities) and development of new recreational infrastructure (systems of paths and cycle routes, adventure play areas, etc) to divert the recreational pressure from the most valuable heathlands;
- Land purchased as alternative open space;
- Provision of more rangers and wardens;

- Purchasing monitoring equipment;
- Land management to reduce fire load and risk of fires;
- Purchasing fire fighting equipment [2].

The spatial distribution of different mitigation projects is highlighted in Figure 5.

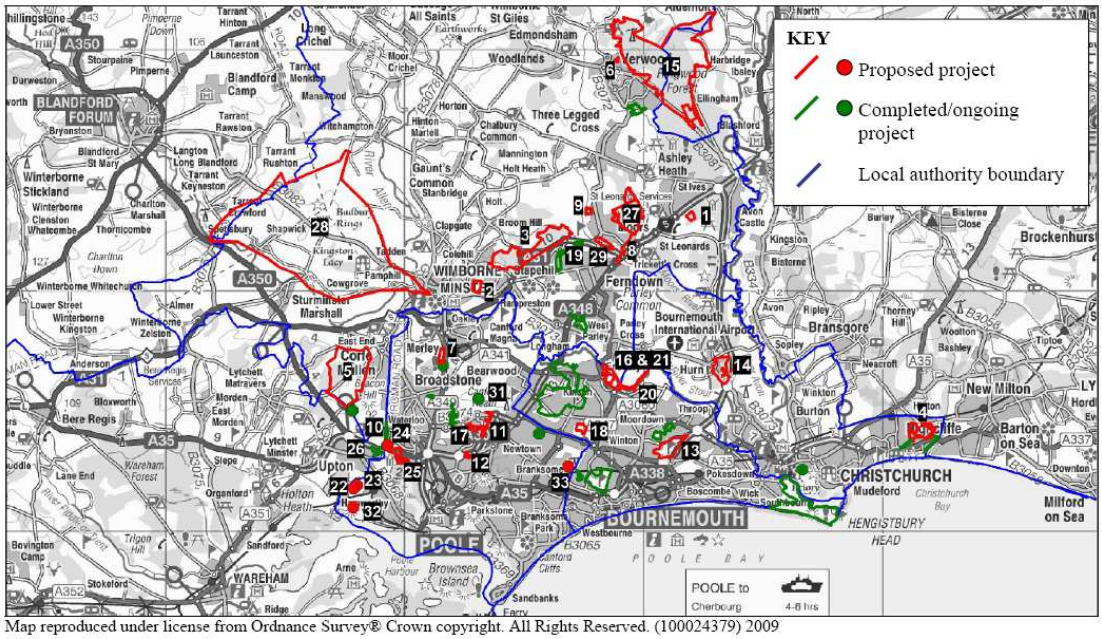

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Figure 5. Location of mitigation projects for 2010-2011 [11]

The mitigation measures outlined above are to be funded by contributions from developers who receive planning permission for residential buildings within the zone between 400m and 5km from protected heathland sites (see Figure 4). The obligation will be applied to every residential development, regardless of number of units proposed, where there is a net increase in dwellings (i.e. the obligation is not applied to extensions). The financial contribution will be based upon a standard charge, with adjustment for the different occupancy rate for houses and flats, to provide the clarity required by developers, the owners of land and the general public. This approach is designed to avoid unnecessary delay in the negotiation of planning obligations. To provide certainty to those making applications for residential development and to ensure transparency and accountability, a formulae approach has been adopted that sets out a mechanism for the calculation of the planning obligation. The factors that are taken into account for calculating the developers' contribution are included in table 1.

Table 1. Factors considered in calculating the developers' contribution [11]

Factor	Number
Forecast 2 year average population increase in south east Dorset by type of dwelling 2009-2026	3047
Regional Spatial Strategy housing requirement for the area 2009-2026	4112
Relative proportion of households (houses / flats)	73 / 27
Projected net population increase per dwelling (houses / flats)	1.5 / 0.9
Cost of the mitigation measures (as of September 2009)	£3.5m

The cost of mitigation divided by the forecast population growth i.e. £3.5m divided by 3047 gives a charge per person of £1,149. However an adjustment to the charge to allow for the net population increase per dwelling type results in a charge per dwelling of:

- Cost per house (£1,149 x 1.5) of £1,724.00
- Cost per flat (£1,149 x 0.9) of £1034.00

It is also necessary to discount the cost of the existing residential unit on site, for example, if a single dwelling house is proposed to be replaced by 10 flats then the calculation would be: 10 x cost of a flat minus the cost of 1 house.

Implementing the initiative

The interim strategy for the protection of Dorset's heathland has been in operation since 2007, and the Interim Planning Framework was reviewed in April 2010. This will be in place until the end of 2011, by which point the local planning authorities involved in the process have agreed to have in place a joint Heathland Development Plan Document (DPD) which will form part of their statutory spatial plans (known as Local Development Frameworks). The joint DPD will be informed by appropriate assessments and detailed research into the impact of urban pressures on protected heath [(11)].

The Interim Planning Framework is to be delivered on the basis of Section 106 (S106) of the Town and Country Planning Act 1990, which allows a local planning authority to enter into a legally-binding agreement or planning obligation with a landowner in association with the granting of planning permission. The obligation is termed a Section 106 Agreement. These agreements are a way of delivering or addressing matters that are necessary to make a development acceptable in planning terms. They are increasingly used to support the provision of services and infrastructure, such as highways, recreational facilities, education, health and affordable housing.

The Interim Planning Framework document has to be adopted by all the local authorities in South East Dorset. Each of the partner local authorities is responsible for collecting and accounting for financial contributions. The contributions are held separately from other accounts, and are co-ordinated by the Borough of Poole. The delivery of the Interim Planning Framework is guided by two bodies [(10)]:

1. Dorset Heathland Executive Group, which consists of elected member from each local authority and representatives from Natural England, Royal Society for the Protection of Birds (RSPB) and the Home Builders Federation. They oversee the implementation of the Interim Planning Framework, administer the joint fund and select mitigation projects to be funded;
2. Heathlands Interim Planning Framework Officer Group, including planning and countryside staff from local authorities and staff from nature conservation organisations. They recommend mitigation projects to the Executive Group.

Monitoring and evaluation

The Heathland Interim Planning Framework Officer Group meet regularly to review and consider schemes and to oversee the monitoring process. Progress on the implementation of the Integrated Planning Framework is reported in the Annual Monitoring Reports of the local planning authorities who collect financial contributions. Monitoring is also carried out in order to assess whether the mitigation projects are being effective in practice [(11)].

Sources of funding

The cost of measures to mitigate the impact of urban development on heathland in south east Dorset has been estimated at £3,501,578 (September 2009 prices). On each of the subsequent anniversaries of the adoption of the Interim Planning Framework, the base costs will be adjusted by an amount equivalent to the percentage change in the Retail Price Index. On the fifth anniversary of the commencement of developments that made a financial contribution to the fund, if that contribution has not been spent on mitigation approaches, then it will be returned in full to the developer plus the interest that that money would have earned [(11)].

Stakeholder engagement

Collaboration with key stakeholders

The development of the Interim Planning Framework is based on a collaborative approach between stakeholders operating within the south east of Dorset County. The initiative involves a number of local planning authorities (Borough of Poole, Bournemouth Borough Council, Christchurch Borough Council, East Dorset District Council, Purbeck District Council) and Dorset County Council. The collaborative approach is strengthened through the establishment of the joint Dorset Heathland Executive Group and Heathland Interim Planning Framework Officer Group in 2007 [(11)]. The Framework is supported by Natural England [(9)] and benefits from collaboration with the well established Urban Heath Partnership.

Public consultation

The Local Authorities party to The Dorset Heathlands Interim Planning Framework issued a revised version for public consultation on 17 November 2009 for a period of 8 weeks. The public consultation document was available on the websites of the relevant local authorities and in local libraries. In addition, all registered stakeholders with an interest in the Dorset Heathlands were mailed directly informing them of the consultation. The main decisions and/or changes occurring as a result of the consultation exercise were:

- An extension of the Interim Planning Framework until the end of 2011;
- Confirmation of the list of mitigation projects (see Figure 5);
- Contribution levels to remain as set out in the consultation document;
- Not to include a threshold for large scale development;
- Collection of payment of obligation on commencement of development [(11)].

Can it have an impact?

The initiative aims to fund measures that would mitigate the impact of urban development on heathland (including fire risk) through contributions made by developers who obtain planning permission for new development within 400m-5km distance from a protected heathland site. In other places in England more drastic measures have been taken: for example in Surrey, Natural England introduced a complete ban on new developments within 5km from heathland sites. However, in Dorset, it was believed that the joint approach of the local authorities and the system of funding mitigation measures by developers' contributions would be sufficient.

Indeed, to date the scheme is seen as successful. Natural England's opinion is that the selection of mitigation measures can reduce to an insignificant level the harm that would otherwise occur to protected heathland from new developments [(11)]. In 2008, the project collected £1.75M, and a number of mitigation projects are being implemented across South east Dorset, including wardening and policing, community education and awareness raising, fire risk assessment and management, projects to divert recreational pressures away from the heaths, access management projects and recording and monitoring [(10)]. The system of calculating the financial contribution is clear, robust and easy to operate [(11)]. In addition, the legal basis in nature conservation regulations provides a clear reference point for considering appeals to planning permission decisions (NE, 2006).

What needs to be remembered is that this interim planning framework is only applicable to dwellings, including houses, flats and maisonettes. Other accommodation types such as student halls of residence, hotels, holiday parks and residential nursing homes which fall within a separate use class will be subject to assessment outside of this framework. The alternative option of basing contributions on bed spaces has been rejected due to the weak correlation between bed spaces

and occupancy rates. However as part of the preparation of the joint Heathland DPD alternative options are being considered [11].

Key messages

- A previously existing partnership was used as a basis for development of the Interim Planning Framework. Also, the participation in the LIFE-Nature project allowed for collection of necessary evidence and development of experience in application of various mitigation measures.

- The collaborative approach is preferable to local authorities applying mitigation measures individually. Focus on the entire area where heathland is concentrated, consistency of approach, pooling of developers' contributions and collective prioritisation of the mitigation projects are the main advantages of the collaborative approach.

- Development of statutory policies in the Local Development Frameworks of the planning authorities in the near future will be an additional benefit helping to drive forward the implementation of associated mitigation projects.

- The use of Section 106 agreements based on biodiversity protection requirements for developers to contribute to is an innovative funding mechanism for mitigation of urban pressure on heathland across the south east Dorset area.

- The measures applied are not only physical. Engagement with the local community is emphasised to increase the awareness of fire danger and other negative impacts on heathland.

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Berlin: The Biotope Area Factor

Climate change impacts addressed	High temperatures Urban flooding
Spatial scale	Town or city
Response type	Regulations
Themes driving the initiative	Biodiversity conservation Quality of life and attractiveness of place
Factors of success	Internal collaboration Sound evidence base

Summary

In Berlin, plans for the development of new buildings now fall under a regulation that requires a certain proportion of the development area to be left as a green space. The proportion of green space to the entire development area is referred to as the Biotope Area Factor (BAF or BFF for *Biotop Flächenfaktor*). The regulation is a part of a larger suite of documents relating to landscape planning, landscape design and species protection. It responds to the need to encourage more green space areas to be developed in densely built-up urban locations. An important advantage of the BAF regulation is that it allows flexibility of the site design; the developer may decide what green space measures are applied, and where, as long as the required green space ratio is achieved. The Biotope Area Factor has generated a significant international interest.

Case study location

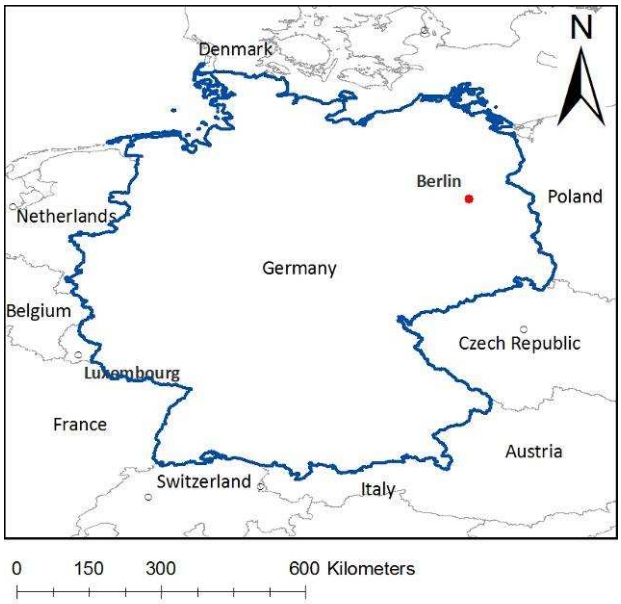


Figure 1. Location of Berlin

After the fall of the wall, Berlin became the new federal capital of Germany. The population of Berlin is almost 3.4 million. Berlin is one of three German city-states, which combine the functions of city and state. Berlin's executive body is the Senate of Berlin (Senat von Berlin), consisting of the Governing Mayor (Regierender Bürgermeister) and up to eight senators holding ministerial positions. There are 12 boroughs in Berlin, each with a mayor and six councillors [(1)].

Berlin's city centre is characterised by high density development. This development pattern influences environmental conditions, resulting in a high degree of soil sealing, inadequate replenishment of groundwater due to the rapid runoff of rainfall into the sewage system, lack of humidity and excess warming, and biodiversity pressures due to inadequate green space cover [(2)].

Berlin has an Oceanic climate (Cfb) according to the Köppen climate classification system. The city features a temperate climate. Summers are warm with average high temperatures of 22–25°C and lows of 12–14°C. Winters are cold with average high temperatures of 4°C and lows of −2 to 0°C. Berlin's built environment creates a microclimate, with heat stored by the city's buildings. Temperatures can be 4°C higher in the city than in surrounding areas. Annual precipitation is 570 millimetres with moderate rainfall throughout the year. Light snowfall mainly occurs from December through March, but snow cover

does not usually remain for long[8]. The future climate projections indicate a rise in mean annual temperature of 2.2ºC by the 2080s under the medium-high emissions scenario. In the summer, precipitation is projected to decrease by around 10%, while in winter it is projected to increase by 10-30% (3).

Development of the initiative

Key aims

In the city centre, the Biotope Area Factor (BAF) is a particular approach targeted at safeguarding and enhancing the presence of vegetation in the built environment. The key aim is to ensure that a given proportion of a particular site area is left undeveloped, i.e. covered by vegetation (2). The BAF strategy aims to retain high densities of development, whilst also developing the city's green infrastructure (4).

BAF = Ecologically-effective surface areas / total land area

Themes driving the initiative

Ecological traditions
Germany has one of the strongest ecological traditions in Europe. There is a widespread appreciation of the benefits of nature in towns and cities, particularly in respect of making cities more liveable. This is important given the preference for high density housing in Germany. Consequently, Berlin is in exemplar with its pioneering green infrastructure and community forestry projects (4). The main driver behind the BAF strategy was the need to reduce the city's impact on the environment by compensating for current deficits in open space. The approach was guided by the Landscape Programme for Berlin (2).

The Landscape Programme 1984/1994
The Landscape Programme for West Berlin was introduced in 1984. At that time, nature conservation was a priority for almost all political parties, which secured high level backing for the Programme. At a technical level, a great amount of effort was put into collecting the basic information needed for an inventory of West Berlin's nature and landscape, and into developing initial suitable evaluation methods and procedures. The recruitment of additional administrative staff in 1985 speeded the process up considerably, and helped to make the Programme what it is today (5). The main strategies of the Landscape Programme focus on the protection of nature and wildlife, natural resources, landscape, and recreation areas (1). The Biotope Area Factor fits into the nature and wildlife protection strand of the Programme.

Political and financial situation in Berlin
The unique opportunity to develop the vast central area of the city after the reunification of East and West Berlin provided a testing ground for innovative large-scale green infrastructure projects (1). Plans highlighting Berlin's existing habitat networks have been prepared, which divide it into different character areas. These include central city (where BAF is used to secure presence of vegetation); transition areas (mixed use, where green linkages are prioritised), and landscape elements in the periphery of urban areas, where larger habitat "fingers" penetrate into the urban

[8] World Meteorological Organisation http://www.worldweather.org/016/c00059.htm

area [4]. At the same time, planners were confronted with the challenges associated with a potential growth in the population of up to 300,000 in the city and up to 1.5 million in the region, alongside demands for 550 hectares of new building land for commercial businesses, offices and retail. A speedy decision was made to abolish allotment areas in central locations as a means of securing land in return for an agreement to protect open spaces and climatically important mitigation areas and recreation areas on the city's outskirts [5].

The greening of the urban environment in the 1980s and 1990s was mainly implemented by providing financial incentives and subsidies to developers and residents (Box 1). The city of Berlin has since suffered deficits, and the programme of direct financial incentives has been replaced by a system of fees and regulations [1].

Box 1. Green courtyards and green roofs in Berlin

Berlin has a long history of planning for green spaces in densely developed areas. The Courtyard Greening Programme (1983-1996), aimed to add green space in the form of green roofs, green facades and backyard community gardens in the most densely built-up areas of the city. The aim was to improve urban climate, quality of life for residents, and the urban amenity. On average each square meter of green space was subsidized with 19.10 € of funding, which included separate amounts for construction and design. During the period of the program, 54 ha of courtyard and roofs were greened and 32.5 ha of facades were greened. This translated into subsidies worth €16.5 million. This initiative has helped the Landscape Programme to implement goals relating to increasing green space in the city [5].

Approximately 65,750 m² of extensive green roofs have been subsidized. Residents received a reimbursement for about half (25-60 €/m²), of their expenses for the cost of green roof installation [1].

Details of the initiative

A fundamental objective of the Landscape Programme is to find fair planning solutions which, without losing the urban character of the city, integrate open spaces and vegetation around developments thereby making the most of the limited space available in the city. The Landscape Programme complements the process of town planning and preparation of the spatial development plan (The Land Use Plan), setting qualitative goals for urban planning. The Landscape Programme focuses on resolving land use conflicts resulting, for example, from new infrastructure developments and plans for building on land for residential use, industry, commerce and services[5].

The Biotope Area Factor (BAF) was developed in the 1980s in Berlin's western sector before reunification, and was introduced as a binding document in 1994 [4]. The BAF is similar to other urban planning parameters used to regulate development planning such as the gross floor area, the site occupancy index, and the floor space index. The BAF expresses the ratio of the ecologically effective surface area (area covered in vegetation) to the total land area covered by the development.

All potential green areas, such as courtyards, roofs, walls, and fire walls, are included in the BAF. However, different types of green spaces are weighted differently according to their evapotranspiring qualities, permeability, possibility to store rain water, relationship to soil functioning and provision of habitat for plants and animals (Table 1). Figure 2 presents examples of greening of courtyards in Berlin.

Table 1. Weight of different types of surfaces [2]

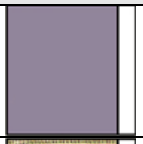
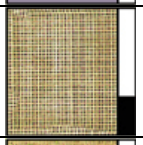
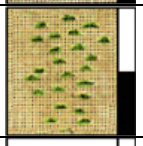
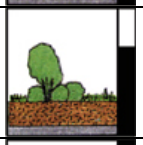
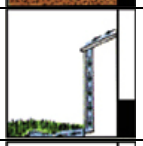
Surface type		Weighting factor
Sealed surface Impermeable to air and water and has no plant growth (concrete, asphalt, slabs with a solid subbase)		**0.0**
Partially sealed surfaces Permeable to water and air, but no plant growth (mosaic paving, slabs with a sand/ gravel subbase)		**0.3**
Semi-open surfaces Permeable to water and air, some plant growth (gravel with grass coverage, wood-block paving, honeycomb brick with grass)		**0.5**
Surfaces with vegetation unconnected to soil below On cellar covers or underground garages with less than 80 cm of soil covering		**0.5**
Surfaces with vegetation unconnected to soil below No connection to soil below but with more than 80 cm of soil covering		**0.7**
Surfaces with vegetation connected to soil below Vegetation connected to soil below, available for development of flora and fauna		**1.0**
Rainwater infiltration per m² of roof area Rainwater infiltration for replenishment of groundwater; infiltration over surfaces with existing vegetation		**0.2**
Vertical greenery up to 10m in height Greenery covering walls and outer walls with no windows; the actual height, up to 10 m, is taken into account		**0.5**
Green roofs Extensive and intensive coverage of rooftop with greenery		**0.7**

Figure 2. Examples of greening of courtyards [5]

Implementation of the initiative

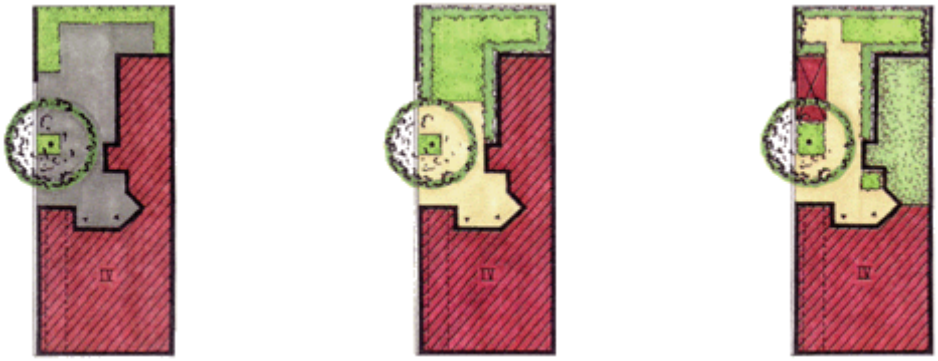
The Landscape Programme, which includes the BAF initiative, is implemented through Landscape Plans. Their binding nature as statutory instruments gives Landscape Plans a strong political, administrative and public mandate. Landscape Plans now exist for around 16% of Berlin's urban area [5].

The BAF was formally established in as an element of Landscape Plans in 1994, and now has legally binding force in Landscape Plans for selected parts of the city [2]. There are currently 21 BAF Landscape Plans in Berlin [5]. The legally-binding elements of the BAF are described in Berlin's Handbuch der Berliner Landschaftspläne (in German only) [6]. The BAF covers all forms of urban land use - residential, commercial, and infrastructure - and formulates ecological minimum standards for structural changes and new development. The objective is to achieve the BAF target values listed in Table 2 [5].

The BAF Landscape Plan is generally put into practice on the basis of building permits [5]. This involves planting greenery for facades and/or on roofs, and re-opening hard surfaces in courtyards for the creation of green areas and to encourage rain water infiltration. BAF leaves the fine design details to the developer. However, common features include greening of functional spaces (e.g. bike or bin sheds); planting trees and shrubs or, in smaller areas, climbing plants; introducing green roofs; paving only on main routes and using permeable surfaces elsewhere [7]. Figure 3 presents two examples of greening, which allow for achievement of the BAF standards.

Table 2. BAF targets for different types of developments [2]

Alterations or extensions of existing development		**New development**
Degree of coverage	**BAF**	
Residential units		
up to 0.37 0.38 to 0.49 over 0.50	0.60 0.45 0.30	0.60
Commercial use		
N/A	0.30	0.30
Commercial enterprises and central business facilities; administrative and general use		
N/A	0.30	0.30
Public facilities		
up to 0.37 0.38 to 0.49 over 0.50	0.60 0.45 0.30	0.60
Schools and education complexes		
N/A	0.30	0.30
Nursery Schools and Day Care Centres		
up to 0.37 0.38 to 0.49 over 0.50	0.60 0.45 0.30	0.60
Technical Infrastructure		
N/A	0.30	0.30



Current situation BAF = 0.06	Planning variant A BAF = 0.3	Planning variant B BAF = 0.3
Sealed surface = 140m² Semi-open surface = 59m² Open soil =1 m²	Vegetation = 115 m² Mosaic paving = 25.5m²	Concrete surface = 21 m² Vegetation = 79 m² Mosaic paving = 100 m² Green walls = 10 m² Green roofs = 41 m²

Figure 3. Example of different methods of achieving BAF of 0.3 [2]. In this example, land area = 479 m² and the degree of development is 0.59.

Sound evidence base

The City of Berlin has an extensive database of maps presenting environmental conditions in the city and land use characteristics. The different climatic zones of the City of Berlin have also been mapped, taking into consideration air temperature, humidity and soil moisture (Figure 4). Based on this information, the BAF strategy seeks to use green infrastructure to deliver benefits in terms of air conditioning, microclimate control and flood attenuation [7]. Also, the building – to – land ratio has been mapped for the City of Berlin (Figure 5). In addition, an urban structure map shows different land uses and their percentage of impervious surfaces.

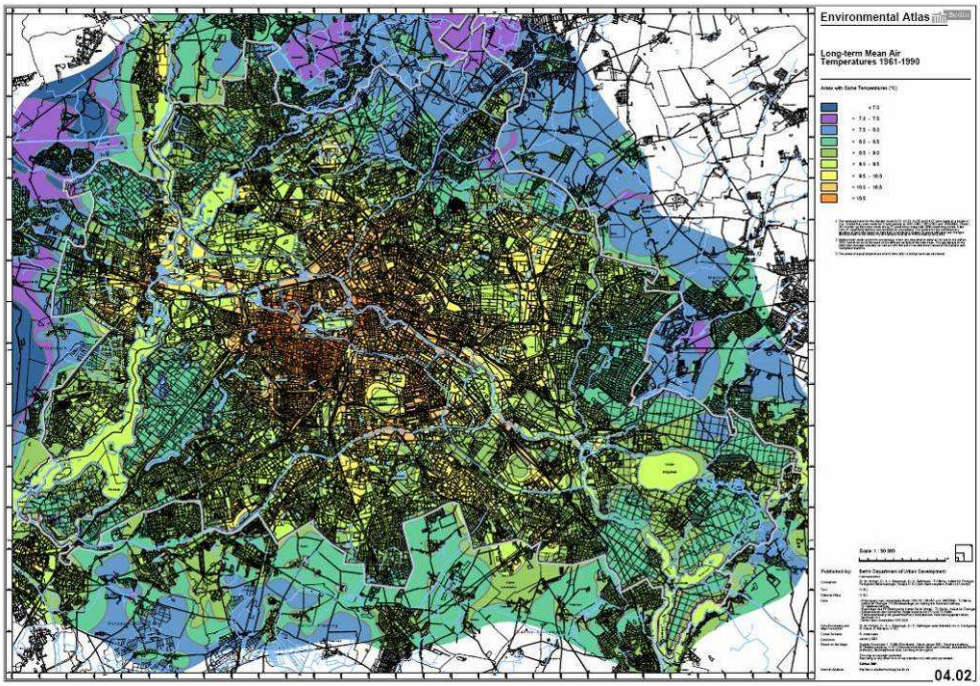


Figure 4. Climatic zones in Berlin [8]

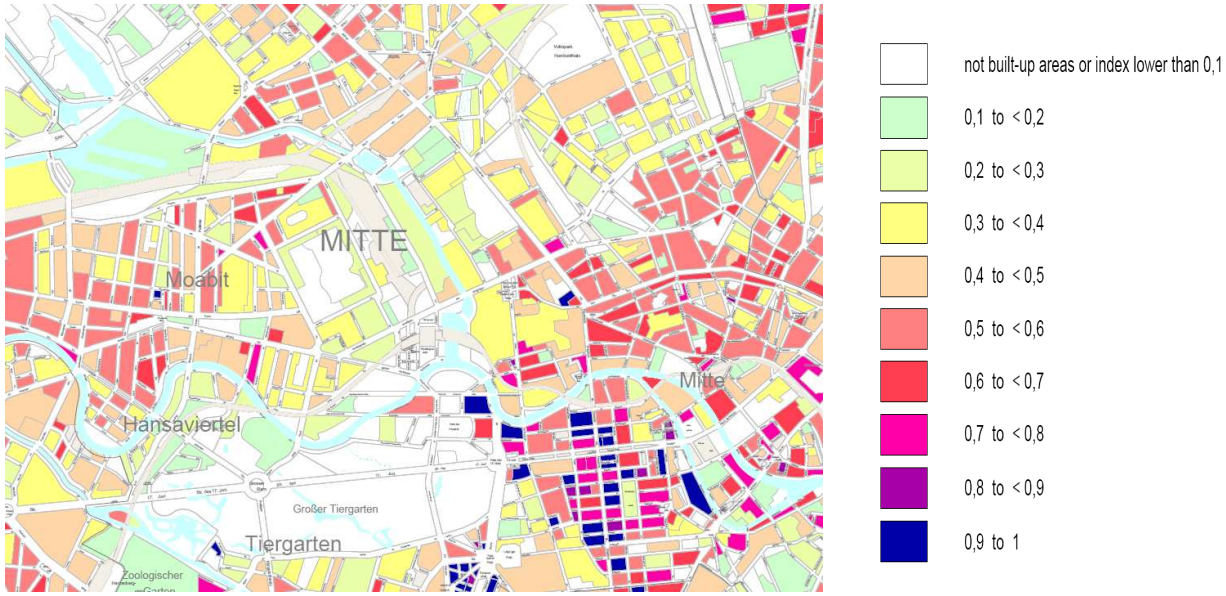


Figure 5. Building to land ratio in Berlin (fragment of the map) [9]

Monitoring and evaluation

A shortage of staff has made it difficult to check the developments for compliance with the standards [1]. However, city planners have received positive feedback from architects and property owners about BAF, as it is easy to use and results in immediate visual improvements, as well as energy savings (in the case of green roofs). In addition, it leaves designers and property owners with room for individuality, creativity and flexibility. City planners appreciate that it is formed in the same logic as other planning indices and ratios, what also makes the training of staff easier [1].

Stakeholder engagement

Collaboration with key stakeholders

The Biotope Area Factor was formulated for inner-city districts of Berlin by a large number of experts who agreed on the necessary proportion of green space areas for different development types, based on the layout of the buildings [5].

Discussions between staff from Berlin's Landscape Planning and Town Planning departments helped to develop new classifications (e.g. for environmental mitigation and replacement measures) in the Landscape Programme. Cross-departmental working also helped to develop a better mutual understanding of the various laws applicable to green spaces [5].

Engaging the public

Public consultation has always been considered highly important for landscape planning in Germany. The Landscape Programme was extensively consulted on with the public in 1986 in a targeted consultation exercise "Berlin hat Pläne (*Berlin has plans*)". The second public consultation for the Programme was held after the fall of the Berlin Wall in 1993, with the Plan finally approved in 1994 [5].

Modifications to Land Use Plans are subject to public participation and consultation phases. These are usually combined into two relatively short annual information and consultation periods. The

coordination and combination of different planning procedures, following a long-term schedule, has strengthened the consultation process with public and other statutory bodies by giving them more time and prior warning to prepare their responses [10].

Information on the Landscape Programme was published on the Internet for the first time in March 1998. The information is aimed at both the interested layman and the professional public, and is updated on a regular basis. With the information available in English, French, Russian and Spanish, queries are received from all over the world. The site registers up to 70,000 hits each month [5].

Can it have an impact?

Scope of adaptation

The Landscape Programme has gained in importance as time has passed. It is becoming increasingly accepted that town planning should take the Programme into account, and it is frequently commented upon and used as a basis for decisions [5].

BAF is only applied to areas where legally binding Landscape Plans are present (16% of Berlin in 21 distinct areas). Outside these areas the BAF is voluntary and can be used as a guideline for encouraging environmental measures to be incorporated when changes to the existing building structures are proposed. While this could significantly limit the applicability of BAF, due to its simplicity and the rising knowledge of environmental issues, architects, builders and property owners tend to use the BAF when it is recommended by experts [1], [5].

In addition, provision of green spaces is supported by national legislation. In the German constitution, there is a clause about private property owners having responsibilities for promoting social good. This means that property owners have a responsibility to the greater community to provide green space [1].

Whilst the BAF has been introduced into spatial planning as a nature conservation measure securing presence of habitats, the provision of vegetation in densely-developed areas has a significant potential to attenuate impacts of climate change such as occurrence of heat waves and the risk of flooding from intense precipitation events.

Additional benefits

The BAF contributes to standardizing and putting into practice the following environmental quality goals:

- Safeguarding and improving the microclimate and atmospheric hygiene,
- Safeguarding and developing soil function and water balance,
- Creating and enhancing the quality of plant and animal habitats,
- Improving the residential environment [2].

Information on the Biotope Area Factor is also available on the Internet, with worked examples in English and French. Since its inception, information on this method has been requested from abroad from countries such as Canada, Italy, Denmark, Finland and Puerto Rico, where it has been adopted unchanged or modified for use in their spatial planning systems [5]. Based on BAF, the Greenspace Factor was implemented in an urban development in Malmö, Sweden in 2001. In 2007, the City of Seattle, USA, developed its own Green Factor (http://www.seattle.gov/dpd/Permits/GreenFactor/Overview/) [11].

Key messages

- Use of regulations rather than financial incentives has proven to be an effective means of increasing green cover in Berlin.

- Flexibility of the approach provides significant advantages. Developers can choose between a number of different options for greening or creating permeable surfaces, and pick those that are the most beneficial for themselves and the users of the development.

- Collaboration between the departments of landscape planning and land use planning ensured that the two planning instruments central to the implementation of the BAF are working in a coordinated way.

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Augustenborg, Malmö: Retrofitting SUDS in an urban regeneration area

Climate change impacts addressed	Urban flooding
Spatial scale	Neighbourhood
Response type	Delivery of physical infrastructure
Core drivers	Response to current climate Quality of life and attractiveness of place
Good practice	Leadership / championship External collaboration Public engagement Cohesive delivery of multiple benefits

Summary

The neighbourhood of Augustenborg (Malmö, Sweden) has experienced periods of socio-economic decline in recent decades, and frequently suffered from floods caused by overflowing drainage systems. Augustenborg underwent a significant regeneration between 1998 and 2002. The main drivers for this regeneration initiative were the difficult social and economic situation in the neighbourhood, flood risk management, waste management and biodiversity improvement. Significant physical changes in infrastructure took place as a result, focusing on the creation of sustainable urban drainage systems, including ditches, retention ponds, green roofs and green spaces. The project was carried out collaboratively by the city council and a social housing company, with extensive participation of the residents in Augustenborg. The project has resulted in a successful outcome as the rainwater runoff rates have decreased by half, and the increase in green space has improved the image of the area.

Case study location

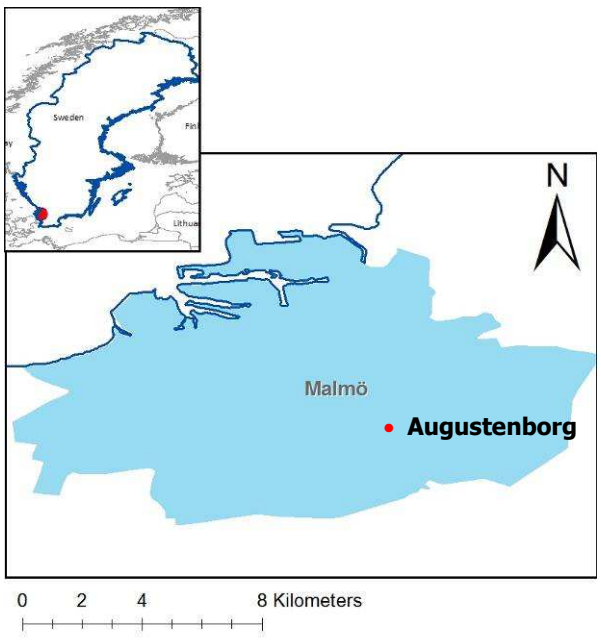

Figure 1. Location of Augustenborg

Malmö is located in the south of Sweden and is the country's third-largest city, with a population of 286,000. Malmö used to be a successful industrial city. However, the oil crisis in the 1970s caused closures of shipyards and textile industries generating severe unemployment. Since the 1980s Malmö has reinvented itself as an eco-friendly, multi-cultural and knowledge-based city [(1)].

The Augustenborg neighbourhood, located in the Fosie district (Figure 1), is about 32 ha in size and contains 1,800 apartments, 1,600 of which are rented from the Malmö Municipal Housing Company (Malmö Kommunala Bostadsbolag - MKB) [(2), (3)]. Most of the multi-family houses are 3 stories high, some houses are 7 stories. The neighbourhood is home to 3,000 residents. It was built in the 1950s as one of the first housing estates delivered under Sweden's social housing policy, and was initially considered to be a highly successful mixture of housing, employment and social facilities. However, by the 1970s the

neighbourhood fell into decline, impacted on by economic difficulties at the city level. The estate suffered a spiral of decline as more people moved out, flats remained unoccupied, and the residual population became marginalised with high levels of unemployment [(2)]. Augustenborg has also been challenged by high levels of resident turnover and a high percentage of immigrants who started arriving in the 1990s [(4)]. Problems with the built environment included damp, inefficient insulation and poor appearance. Most importantly, the neighbourhood suffered from flooding from the sewage and drainage system, the capacity of which was exceeded during heavy rainfall events. The in-migration to Malmö in the 1980s and 1990s brought cultural diversity to the neighbourhood. The regeneration efforts in Augustenborg started in the 1990s, and developed into the Ekostaden Augustenborg project.

Malmö has a mild, oceanic climate, despite its northern location. In summer average high temperatures reach 18-21°C and low temperatures are around 10-12 °C, but temperatures do sometimes exceed 25°C and occasional heat waves occur. Winters are cold, with temperatures steady between −3-4°C, rarely dropping below −10°C [(5)]. Rainfall is light to moderate throughout the year, with an average of 169 wet days and 600mm rainfall per year. The second half of the year is the wettest, with November having an average of 60mm precipitation. The months from January to June normally have less than 50mm precipitation and the driest month, is February with an average of 30mm [(3)]. Snowfall occurs mainly in December through to March, but snow covers do not usually remain for a long time, and some winters are virtually free of snow.

Prior to regeneration, Augustenborg was prone to annual flooding caused by the old sewage drainage system being unable to cope with the combination of rainwater run-off, household waste water and pressure from other parts of the city. Resulting flooding was leading to damage to underground garages and basements, and restricted access to local roads and footpaths. Untreated sewage also often entered watercourses as a result of increasing pressure on the sewage treatment works [(2)].

Future climate projections for Malmo developed by the Swedish Commission on Climate and Vulnerability [(6)], estimate an increase in average January temperature of 2°C by the 2020s and 6°C by the 2080s. The summer (July) increase in the temperature is projected at 2°C by the 2020s and 4°C by the 2080s. The number of days in the summer with a maximum temperature above 20°C could increase to 10 in 2020s and to over 50 in 2080s. The precipitation patterns will also change with wetter winters and drier summers. Summer precipitation is likely to fall by 30mm per month. The precipitation in January is likely to increase by 30mm in 2020s and 50mm in 2080s compared to the 1961-1990 baseline. The number of heavy downpours in autumn and winter are projected to increase, with up to 8 days with over 10mm of precipitation possible by 2080s. This is likely to exacerbate the problems associated with rain water runoff management in urban areas.

Development of the initiative

Key aims

'Ekostaden Augustenborg' is the name for the regeneration initiative of Augustenborg neighbourhood in Malmö. The key aim of the initiative was to create a more socially, economically, and environmentally sustainable neighbourhood. The City of Malmö and MKB set the initial scope of the Ekostaden Augustenborg project, which focused on combating flooding, waste management and enhancing biodiversity. In order to minimise flood risk, rainwater from roof tops and other impervious surfaces is now collected and channelled through canals, ditches, ponds and wetlands before finally draining into a traditional closed sub-surface storm water system (Figure 2).

Themes driving the initiative

The main driver behind the initiative was the regeneration of the neighbourhood with firm focus on innovative environmental improvements, including reduction in flooding, improved waste management, and biodiversity enhancement [(2)]. The direction and focus of the urban regeneration initiative was partly dictated by the changes at the city level, which was pursuing policies relating to moving from post-industrial to environmentally sustainable city [(1)]. While adaptation to climate change was not an explicit driver, the project aimed to address the issue of urban flooding, which is one of the climate change effects that is likely to be exacerbated in the future in this area. Measures addressing urban flooding were combined with those aiming at reduction in CO_2 emissions, and at improved waste management.

Figure 2. Sustainable urban drainage system in Augustenborg (Photograph: GRaBS)

Details of the initiative

The introduction of a Sustainable Urban Drainage Systems (SUDS) was part of the broader regeneration project, Ekostaden Augustenborg. This project also involved initiatives aiming at improvement of energy efficiency and energy production, electric public transport and car pooling, and recycling [(2)]. Due to recurring flooding problems it was proposed that stormwater from Augustenborg should be disconnected from the existing combined sewer, and drained by means of an open system. The main intention was to reduce flooding by 70%, eliminating combined sewer overflow completely, by both lowering the total volume of stormwater reaching pipes and reducing the peak flow rates. This has been achieved by reducing the impervious areas and the associated runoff, preserving and enhancing green spaces, and managing stormwater to reduce total runoff [(3)].

The stormwater management system created in cooperation with MKB, the Water Department, landscape designers, and local residents in Augustenborg interested in water management issues, now includes a total of 6km of canals and water channels and ten retention ponds [(2)]. Rainfall is collected in natural ditches and reservoirs before directing it into a conventional sewer system. The rainwater from various roofs, roads and car parks is channelled through visible trenches, ditches, ponds and wetlands (Figure 3). These landscape features are integrated into the townscape within

30 courtyard areas, which also provide recreational green spaces for the area's residents [1]. Whilst green spaces were increased in size and number, the specific style of the 1950's was maintained so as not to compromise the aesthetics of the area [2]. Some of the green spaces can be temporarily flooded, which helps to manage water by slowing its entry into the conventional storm water system.

In addition, green roofs have been installed on all developments built post 1998. Some buildings existing prior to 1998, such as garages that have been reused as offices, have also been fitted with green roofs. Altogether, there are 30 green roofs in the neighbourhood and 2,100 m^2 of green roofs are provided on MKB houses. In addition, a Botanical Roof Garden, which covers 9,500m^2 of an old industrial roof, was developed between 1999 and 2001, and remains the largest green roof in Scandinavia [2].

The alternative option of reducing flooding via a conventional separated stormwater system for Augustenborg would have meant major earthworks. This approach could also have caused problems further along the stormwater drainage network, such as bottlenecks where the system joins with older pipes. Moreover, the receiving areas could have suffered increased flood risk, erosion or water quality degradation [3]. Therefore, the implementation of the open stormwater system described above was considered to be the most sustainable option aligning with the vision of the regeneration initiative Ekostaden Augustenborg.

Figure 3. Sustainable urban drainage system in Augustenborg (Photograph: GRaBS)

Implementation of the initiative

The project was started in 1997, and ran between 1998 and 2002. The work on the SUDS infrastructure began in December 1999, and finished in the summer of 2000. The system has been operational since May 2001 [3]. The implementation of the initiative was co-managed by the City of Malmö and the MKB social housing company. Close cooperation between these bodies allowed negotiation of management responsibilities, which are crucial for maintaining the initiative in the long term. The MKB and the City of Malmö agreed a joint management contract for the waste, water and green space systems, which is said to be working effectively [2].

The project involved retrofitting SUDS within existing development and infrastructure, and with residents in situ, which presented a challenging task. Specific challenges associated with the design of a system that was functional, did not damage existing buildings and infrastructure, and was acceptable to local residents, are listed in Box 1. These problems were solved by redesigning, re-siting and in some cases not implementing certain elements of the system, utilising

technological solutions, and extensive consultation with local residents (see the section on stakeholder participation). Other problems associated with the project were the unavoidable noise and dust during construction, which caused complaints from local residents [3]. In addition, the retention ponds were prone to algae growth, and a technical solution was designed to solve this problem [2].

Box 1. Design challenges to implementation of sustainable urban drainage systems in Augustenborg [3]

- Finding physical space to incorporate the SUDS into the already existing development:
  - The SUDS had to be fitted around existing electricity, water, heating and telephone infrastructure;
  - Access for emergency vehicles had to be maintained;
  - Many residents were concerned that large percentage of the accessible green space was not suitable for recreation, and that some trees were removed.
- Buildings could not be damaged by water. Thus, all SUDS were underlain with geotextile, removing the possibility for increased deep percolation and limiting the system's function to water retention rather than infiltration.
- Health and safety issues had to be solved. The SUDS were located within and in close proximity to school grounds, and concerns were raised about the drainage channels posing obstacles to elderly and disabled.
- Aesthetics were more important to many residents than the functioning of the system.

Sources of funding

The total sum invested in the physical improvements in Augustenborg and related projects was around SEK 200M. Around half of the sum was invested by MKB. Remaining funding mainly came from the local authorities, principally the City of Malmö, in addition to several other sources which included [2]:

- The Swedish government's Local Investments Programme for Ecological Conversion and Eco-Cycle Programme (SEK 24M);
- The Swedish Department of the Environment (SEK 4M) and EU programme LIFE (SEK 6M) provided funds for the creation of the Botanical Roof Garden;
- EU URBAN programme also supported the regeneration of Augustenborg.

Management work is jointly funded through the housing company, which incorporates costs into rents, the water board through the water rates, and the city council's standard maintenance budgets.

Stakeholder engagement

Collaboration with key stakeholders

The key actors involved in the regeneration of Augustenborg were the MKB housing company and the City of Malmö, represented by the Fosie district and the Service Department [2]. However, several individuals were particularly important to the success of the project. The process of creation of Ekostaden Augustenborg began in 1997, and was started by discussions about closing down a nearby industrial area. Peter Lindhqvist from The Service Department, City of Malmö, suggested that an eco-friendly industrial park opened in the area. At the same time Bertil Nilsson, former headmaster at the school in Augustenborg, had become one of the co-ordinators of the

Swedish Urban Program in Malmö. He contacted Christer Sandgren at MKB who was their housing manager for Augustenborg and had the mission to renew the area. The three men gathered a group of senior officers, colleagues and active residents in the area who all wanted to turn the area into a sustainable district of Malmö. A project leader, Trevor Graham with experience from Groundwork in England, was hired in 1998 [(2)]. As the project progressed, local businesses, schools and the industrial estate became involved. The Botanical Roof Garden was developed in a partnership with several universities and private companies.

Engaging the public

One of the main objectives of Ekostaden Augustenborg was to enable residents to play a significant role in the planning and implementation of the initiative. The Augustenborg project incorporated extensive public consultation. This included regular meetings, community workshops, and informal gatherings at sports and cultural events. The approach became increasingly open and consultative [(2)].

While some claim that involvement of local residents was low for a variety of reasons ranging from apathy to language barriers [(3)], approximately one fifth of the tenants in the area have participated in dialogue meetings about the project, and some have become very active in the development of the area [(2)]. Residents and people working in Augustenborg were involved in the design of the outdoor environment. A special needs advisor and local access and mobility group worked with the design team throughout the project [(2)]. Constant communication and in-depth community involvement enabled the project to accommodate residents' concerns and preferences regarding the design of the stormwater system. Consequently, the project encountered little opposition.

Augustenborg school pupils were involved in a number of local developments, for example with the planning of a new community/school garden, rainwater collection pond/ice rink, a musical playground, and sustainable building projects incorporating green roofs and solar energy panels [(4)].

The greatest challenge in involving the public was maintaining continuity, which involved keeping a steady focus on the environmental awareness of the residents and informing the newcomers to the area about what had been done. He also observed that in order for people to become involved they need to have more control over the project outcomes, and the authorities therefore have to accept that things do not always happen exactly as they were planned [(2)].

Can it have an impact?

Scope of adaptation

It is estimated that 90 % of the stormwater from roofs and other impervious surfaces is led into the open storm-water system in the housing area [(2)]. The open stormwater system is now able to handle runoff volumes locally. The implementation of an open stormwater system at Augustenborg has improved not only stormwater management in the area, but also the performance of the combined sewer system that serves the surrounding area. The volume of stormwater draining into the combined system is now negligible, and this system now drains almost only wastewater [(3)].

In addition, modelling work has shown that the total annual runoff volume is reduced by about 20% compared to the conventional system. This is due to evapotranspiration from channels and retention ponds between the rain events. Also, the runoff peak flows are delayed and attenuated [(3)].

The partnership involved in the design of the project was aware that climate change is projected to worsen still further flooding problems in the city. While no climate change analysis was carried

out on the open storm water system, it was designed to accommodate a 15 year rainfall event as the baseline. Significantly, there have not been any floods in the area since the open stormwater system was installed [2]. Moreover, a 50 year rainfall event was experienced in the summer of 2007, which cut most of Malmö off from rest of Sweden. Augustenborg was not affected by this event, suggesting the design of the storm water system is performing better than conventional design standards and that Augustenborg is well prepared for more intense rainfall events in the future.

That the functions of the SUDS in Augustenborg have nevertheless been to some extent compromised by the need to adjust the design to suit the residents' needs. In order to reduce the total flow volume, the storage capacity between storms should be maximised and the surface area of storage areas should be as large as possible to encourage evapotranspiration. However, the residents were concerned about their courtyards being turned into unusable areas of open water. The conflict between people's preferences and the requirements of an efficient stormwater drainage system were to some extent solved by the development of green roofs, which utilised previously unused space [3].

The green roofs in Augustenborg intercept around a half of the total rainwater runoff over the course of a year (the amount absorbed at any time varies according to the saturation level of the roof surface). In addition, the roofs have a significant cooling effect in the summer when compared with standard black bitumen roofs. Consequently, their presence (and that of more open water and green space) will help the area to adapt to projected heatwaves and higher temperatures associated with climate change.

Additional benefits

There is a range of benefits additional to adaptation to more extreme rainfall events that stem from the comprehensive regeneration of the Augustenborg area:

- Reconfiguration of public spaces between housing blocks has given residents opportunities to grow their own food in small allotments, and has created places for leisure and attractive areas for children to play.
- Biodiversity in the area has increased by 50%. The green roofs, predominantly the Botanical Roof Garden, have attracted birds and insects, and the open storm water system provides better environment for the local plants and wildlife. In addition, flowering perennials, native trees and fruit trees were planted, and bat and bird boxes were installed.
- The environmental impact of the area (measured as carbon emissions and waste generation) decreased by 20%.
- The participatory character of the project sparked interest in renewable energy and in sustainable transport among residents, after they heard about similar plans for other areas.
- Between 1998 and 2002 the following social changes have occurred:
  - Turnover of tenancies decreased by 50%;
  - Unemployment fell from 30% to 6% (to Malmö's average);
  - Participation in elections increased from 54 % to 79%.
- As a direct result of the project, three new local companies have started: Watreco AB (set up by local resident and amateur water enthusiast), the Green Roof Institute, and the car pool established in 2000, which uses ethanol hybrid cars to further reduce environmental impacts [2].

To summarise, the environmental improvements, enhancement of the built environment and empowerment of the local community have resulted in Augustenborg becoming an attractive, multicultural neighbourhood. Augustenborg is now seen in a positive light by most residents in Malmö and the Ekostaden project is considered to be one of the most far reaching sustainable urban regeneration initiatives in Sweden [7] and provides learning and inspiration for other areas [8] (Box 2).

Box 2. Augustenborg as an inspiration for other areas

The adaptations at Ekostaden Augustenborg are now being replicated in a number of projects in Malmö:

- The redevelopment of a hospital site in the city is building on lessons learned, and is designing a 100% 'storm water neutral' system, which will manage all storm water within the site's boundaries.
- A project relating to sustainable regeneration of post war housing is analysing what has worked (and not worked) in Augustenborg when it comes to facade renovation, storm water handling and involvement of residents.

In addition, around 15,000 visitors have come to the area, including Augustenborg´s Botanical Roof Garden, from all over the world since the start of the project. There is a constant interest, both local and international, to learn from the example of Augustenborg and global media interest is still strong.

Key messages

- The initiative and enthusiasm of the Service Department in Malmö and housing company MKB. Strong leadership by individuals from these organisations and their professional networks allowed the development of a comprehensive project. In turn, this leadership was only possible due to decentralisation of power from the city to the district level.

- The collaborative character of the project enabled joint management of related issues.

- Participative character of the project. Involvement of the residents in the design phase meant that there was little opposition to the project, and resulted in sense of ownership, empowerment and raised awareness among the residents.

- Extensive funding provided by the local authorities and the housing company.

Contact organisation

www.Malmö.se/sustainablecity

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A Climate Change Action Plan for North West England: Exploring the position of green infrastructure

Climate change impacts addressed	High temperatures Urban flooding River flooding
Spatial scale	Region
Response type	Action Plan
Themes driving the initiative	Adaptation to future climate Mitigation of climate change Quality of life and attractiveness of place Development need despite climate impacts Higher-level policy framework
Good practice	Prioritising adaptation Leadership / championship External collaboration Outsourcing research Sound evidence base Raising awareness internally

Summary

In North West England a regional Climate Change Action Plan was first developed for the years 2007-2009. This was then refreshed in February 2010 for the years 2010-2012. The objective of the revised Climate Change Action Plan is not to replace, but to strengthen the vision of a low-carbon and well adapted region, taking into account progress made to date and developments at national and international levels. Green infrastructure plays a prominent role in the plan, both in terms of its role in climate change mitigation and adaptation. Indeed, one of the stated actions is a "regional assessment of the risks, opportunities and priorities for green infrastructure in adapting and mitigating for climate change". This work is being undertaken as part of the Interreg IVC GRaBS project. The strong position of green infrastructure in the plan reflects a history of research on the subject in the region, as well as a coordinated and structured effort by professionals to embed green infrastructure into regional policy, which has facilitated the inclusion of the concept in statutory regional strategy documents[9]. Key lessons offered by this case study include the significant role of collaborative working during the development of the action plan, and previously in the region on the promotion of green infrastructure including the use of economic arguments to support green infrastructure actions.

The location

North West England is one of the nine official regions of England. It has a population of nearly 7 million people. North West England is bounded to the west by the Irish Sea and to the east by The Pennine hills. The region extends from the Scottish Borders in the north to the Welsh Mountains in the south. Two large conurbations, Liverpool and Manchester, occupy the south of the region and account for much of the region's population. The north of the region, including northern Lancashire and Cumbria, is largely rural (Figure 1).

[9] The change of government in the UK following the 2010 general election is likely to bring with it significant changes to the statutory spatial planning system. The future of the regional tier of governance is uncertain, and some regional level organisations may be lost or reformed with different remits. Changes could also lead to revising the status of regional plans from being statutory to non-statutory. The regional planning documents and the CCAP would nevertheless be likely to remain strong statements of principles and priorities for regional decision makers to draw on.

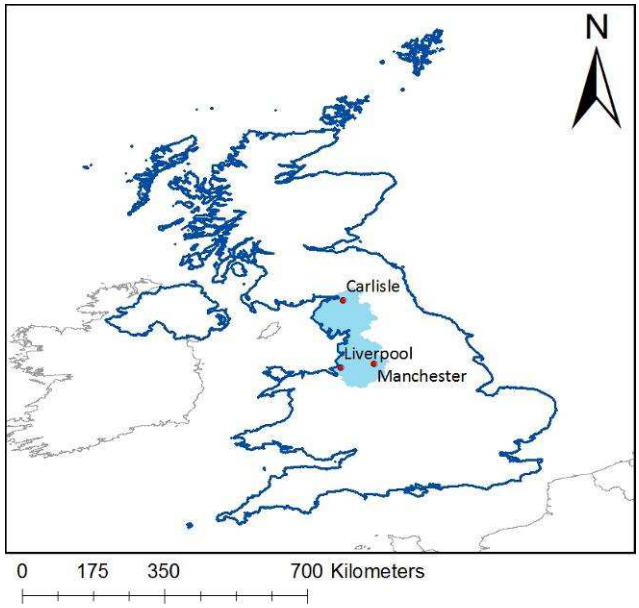

Figure 1. Location of the North West region in the UK

The current climate of the North West is classified as mid-latitude oceanic with warm summers, cool winters and plentiful precipitation throughout the year. The 2009 autumn floods in Cumbria exposed the region's vulnerability to intense rainfall events. The temperature ranges are rarely extreme at the moment.

The UK Climate Projections (2009) [1] show that under a medium greenhouse gas emissions scenario for the 2080s the climate of the North West is projected to change significantly and experience:

- An increase in average summer temperatures with a central estimate of 3.7 degrees;
- 21% less rainfall in the summer, possibly leading to subsidence, lower crop yields and water stress;
- 16% more rainfall in the winter increasing the threat of winter flooding, transport disruption and risks to urban drainage;
- Sea level rise in Liverpool of 30-32cm.

Development of the initiative

Key aims

The North West Climate Change Action Plan 2010 (CCAP 2010) [2] sets out a vision of a ***"low carbon and well adapting Northwest by 2020"***. Adaptation to unavoidable climate change is one of three objectives of the plan, which also include reducing greenhouse gas emissions and capitalising on opportunities for economic growth offered by climate change. The key aim of the CCAP 2010 is to provide the North West of England with a plan of action in order to achieve this vision. The following discussion provides an overview of the development of the CCAP 2010, with a particular focus on the inclusion within the document of green infrastructure as an adaptation response to future climate change impacts.

Themes driving the initiative

Green infrastructure is seen to play an important role in climate change mitigation (carbon storage and sequestration, fossil fuel substitution, material substitution, food production, and reducing the need to travel by car) and adaptation (managing high temperatures, managing water supply, managing riverine and coastal flooding, managing surface water, reducing soil erosion, helping other species to adapt, and managing visitor pressure). Key drivers behind the inclusion of green infrastructure within the CCAP 2010 relate to the presence of the green infrastructure agenda in regional policy and research, and the recognition the green infrastructure can provide significant economic benefits. These two key issues are discussed below.

1. There is a strong presence of the **green infrastructure concept** in regional planning, research and practice. Green infrastructure is defined as multi-purpose open space networks [3] that supports natural and ecological processes and is integral to the health and quality of life of sustainable communities [4]. The definition developed for the North West refers to green infrastructure as the region's life support system – the network of natural environmental

components and green and blue spaces that lies within and between the North West's cities, towns and villages which provides multiple social, economic and environmental benefits [5].

- **Regional Spatial Strategy** [3] states that local authorities need to plan and deliver green infrastructure using existing and bespoke mechanisms. This document states that the use of green infrastructure for adaptation to climate change should be maximised. **Regional Economic Strategy** [6] refers to natural environment as an under-exploited economic asset and calls for development of a regional strategy for green infrastructure. This document also highlights the adaptation function of green infrastructure (see footnote 1 above).

- Research at the **University of Manchester** and work undertaken by the **Community Forests North West**[10] (a quasi-autonomic non-governmental organisation) have provided a scientific evidence base for the importance of green infrastructure in the region.

- Regional stakeholders work together to champion the concept of green infrastructure and support the development of policy. This includes Natural England, Community Forests Northwest, Northwest Development Agency, Government Office Northwest, Northwest Regional Assembly (4NW), Environment Agency, Forestry Commission, University of Manchester and University of Salford, amongst others. Regional structures were set up to facilitate this working, including:

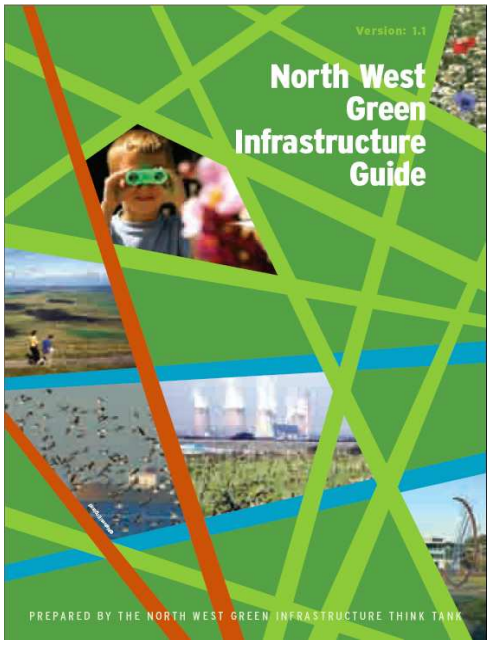

Figure 2. Cover of the North West Green Infrastructure Guide

  - **Green Infrastructure Unit**, a partnership between the Community Forests Northwest and Natural England (national nature conservation agency), which undertakes work including managing the website www.ginw.org.uk, circulates information and stimulates debate amongst local and regional stakeholders. It has championed green infrastructure a critical infrastructure, alongside transport, waste, energy and water.
  - **Green Infrastructure Think Tank**, chaired by the Community Forests North West: a group of academics, consultants and public sector representatives who aim to resolve issues and take the green infrastructure agenda forward. The Green Infrastructure Think Tank developed a Green Infrastructure Guide [5] for use by local spatial planners (Figure 2).
  - **Green Infrastructure Forum**, chaired by the Community Forests North West. The forum provides a place for exchange of knowledge and information to a wider group of stakeholders in the region.

2. The **links between environmental issues and economic development** are increasingly being recognised. At the national level the "**Stern Review**: **Economics of Climate Change**" [7] emphasised that given climate change is happening, measures to help people adapt to related impacts are essential and the longer that adaptation responses are delayed, the more costly they will become. Economic issues and green infrastructure were brought together in a

[10] The Community Forest programme was established in the early 1990s by the then Countryside Commission, the Forestry Commission, and Local Authority Partners. Collectively this work has formed the largest environmental regeneration initiative in England. Major contributions have been made to Government agendas including quality of life, health, community cohesion and addressing climate change.

Natural Economy North West project (2006-2009), championed by Natural England and the North West Development Agency (NWDA) [8]. This project highlighted green infrastructure's role in economic prosperity and stability, which included its climate change adaptation potential. This project proved to be a key factor securing the engagement of senior managers in NWDA on green infrastructure issues. The NWDA's receptiveness to the green infrastructure and climate change adaptation agenda has been crucial to the development of the initiative.

Details of the initiative

The North West Climate Change Action Plan was first launched in November 2006 (CCAP 2007) [9]. It was developed with input from an advisory group of regional partners, organisations and experts. The revised NW Climate Change Action Plan 2010-2012 aims to stimulate and measure the progress of England's Northwest towards a low-carbon economy, preparing it for the challenges of a changing climate and expected future energy demands, whilst protecting and enhancing quality of life and preserving the Northwest's environment. The Plan is separated into five sections, one of which relates to 'a well adapting region.' This section details of a number of prioritised adaptation actions, some of which relate to green infrastructure. CCAP 2010 builds on CCAP 2007 in respect of the role of green infrastructure as an adaptation response.

Adaptation actions within CCAP 2007 were primarily aimed at building adaptive capacity through improvement of the evidence base and understanding the potential scope of adaptation responses required [10]. The particular focus of the CCAP 2007 in terms of green infrastructure was encapsulated in action 4.3, which is [9]:

> ***"To undertake scoping studies to assess future regional risks, opportunities and priorities for the potential for green infrastructure, including regional parks, to adapt and mitigate for climate change impacts and commence implementation of findings."***

This green infrastructure action was led by Community Forests North West. Between 2007 and 2010, a website was set up to house information coming out of the project, and includes an evidence base of research, policy and delivery focusing on the use of green infrastructure in climate change adaptation - www.ginw.co.uk/climatechange. Further, a report on "Critical climate change functions of green infrastructure for sustainable economic development in the North West" [11] was completed. Also, the relationship between green infrastructure and hydrology in a changing climate were investigated.

In the refreshed CCAP 2010, green infrastructure is mainly covered by Action 10, which is [2]:

> ***"To develop a regional adaptation framework which sets out the regional response to projected climate change impacts and capitalises on opportunities for implementation and demonstration."***

This action includes elements relevant to green infrastructure, for example [2]:

- Action 10.2: Flood and coastal risk management through catchment and shoreline management plans
- Action 10.3: The regional assessment of the risks, opportunities and priorities for green infrastructure in adapting and mitigating for climate change.
- Action 10.5: Adaptation response strategies for the region's distinctive landscapes, habitats and species, and the assessment of the contribution of natural systems to carbon sequestration and reduced flood risk.
- Action 10.8: The development and delivery of plans for water efficiency, reliability and resilience; sustainable drainage; and associated carbon reduction.

Implementation of the initiative

The CCAP 2007 covered the period of 2007-2009 and included a number of enabling actions for climate change mitigation and adaptation [(9)]. The CCAP 2010 covers the period 2010-2012. These include actions relating to adaptation using green infrastructure as discussed above. Responsibility for the delivery of CCAP rests with the Regional Strategy Team, comprising the Northwest Regional Development Agency, Government Office for the Northwest, and the Regional Leaders Board (4NW). The Regional Strategy Team is supported by the Environment Agency, and also by key advisory groups, such as the Northwest Energy Council, the Northwest Climate Change Adaptation Group, the Northwest Climate Change Transport Group, the Regional Sustainable Development Group and the NWDA's Board Environment Sub-Committee [(2)].

Each action outlined in the CCAP 2010 is assigned to a lead organisation responsible for defining the detailed steps required to ensure its effective delivery, with assistance from supporting partners. All the organisations responsible for delivering actions in the CCAP form the **Northwest Climate Change Partnership**.

Action 10 of CCAP 2010, which includes adaptation through the use of green and blue infrastructure, is overseen by the **Northwest Climate Change Adaptation Group**. Specifically [(2)]:

- Action 10.2: led by the Environment Agency;
- Action 10.3: led by the Community Forests North West;
- Action 10.5: led by Natural England;
- Action 10.8: led by United Utilities.

Building the evidence base

The 'Adaptation Strategies for Climate Change in Urban Environments' (**ASCCUE**) project led by the University of Manchester (2003-2006) was a key source of scientific information on climate change adaptation in the region. This project also highlighted the role of green infrastructure as an adaptation response. ASCCUE used Greater Manchester as a case study to model future climate scenarios and the potential adaptation response of various green infrastructure interventions [(12)].

In 2008 the report "**Critical climate change functions of green infrastructure for sustainable economic development in the North West**" [(11)] was produced by Community Forests Northwest as part of the CCAP process. The aim of this work was to highlight how and where the climate change mitigation and adaptation functions of existing and/or potential new green infrastructure are critical to the short term sustainable economic development of the NW region. Within this report, 'pinch points' were interpreted as being areas of regional economic importance/interest where there are potential considerations for green infrastructure climate change functionality, and where green infrastructure solutions may overcome the considerations. For example, areas of Salford in Greater Manchester can be seen as a 'pinch point'; it has been identified as a housing market renewal area with significant restructuring and development taking place, yet it is also subject to flood risk. A potential action could be to invest in green infrastructure upstream in the catchment to slow down flood waters, reducing risk of flooding and enabling development.

This report is currently being updated as "Green infrastructure: how and where can it help the Northwest mitigate and adapt to climate change?". Alongside ASCCUE project outputs [(12)] , these reports from Community Forest Northwest provide a strong information base for the use of green infrastructure for adaptation in Northwest England and the development of associated policy initiatives such as CCAP 2007 and 2010.

Monitoring and evaluation

CCAP 2007 included some **provisional regional indicators and targets**, against which its performance could be measured, and a progress report against actions was published in 2008 [(9)]. The CCAP 2010 does not set targets associated directly with adaptation to climate change with the use of green and blue infrastructure. However, it is noted that further targets and indicators will be developed when appropriate data sets become available [(2)].

Stakeholder engagement

Collaboration with key stakeholders

The **NWDA** is the clear leader of the CCAP process. The success of the CCAP lies in its collaborative approach, which was secured by establishing the **Northwest Climate Change Partnership**. This is a group of public and private sector organisations responsible for driving forward and supporting the implementation of the Climate Change Action Plan. Collectively, they are accountable for the delivery of the actions included in the Plan. They also provide advice and recommendations to strategic regional bodies on energy and climate change matters. The partnership was formed in January 2007 and meets quarterly. The membership of the Northwest Climate Change Partnership has evolved to include national and regional cross-sector representation, including city-region and sub-regional partners [(2)].

At their first meeting, the North West Climate Change Partnership recognised that successful delivery of the Action Plan would be reliant upon rigorous coordination and communication of regional activities and effective co-operation between the regional governance organisations. Consequently, a North West Climate Change Unit has been established, hosted by the Northwest Development Agency, to support the implementation of the CCAP and to coordinate the activities of the delivery partners. The Unit acts as a single point of focus for the CCAP. Sub-regional climate change co-ordinators are in place, working with the Unit, to oversee climate change work at the sub-regional level. Since 2007, a climate change adaptation group has been established to specifically support and oversee the delivery of the adaptation actions. Several of the actions "for catalysing action" in CCAP 2010 aim to support existing regional partnerships, look for opportunities for pan-European cooperation and knowledge transfer, and maximise access to new sources of transnational funding [(2)].

In terms of green infrastructure, the engagement of a wide range of actors from outside the NWDA has been central to the prominence of this issue in regional policy and the CCAP. These actors include:

- Government Office North West;
- 4NW - the regional leader's forum, which also secured the political support for the initiative;
- Natural England North West regional office, which co-ordinates projects, research the economic benefits, and facilitate work at regional, sub regional and local level;
- Community Forests Northwest, as the champions of the green infrastructure concept and conveners of the green infrastructure Think Tank and Forum.
- The academic community who have provided a scientific framework for policy to build upon.

Engaging the public

The Northwest Climate Change Action Plan has been developed with input from an advisory group of regional partner organisations and experts. Over 25 workshops and presentations were undertaken as part of the consultation exercise, and over 130 responses were received from groups and stakeholders from across the region. One of the actions in the Plan is to increase good

practice in public engagement to facilitate the development of low carbon energy generation schemes and support Local Authority planning decisions relating to climate change.

Sources of funding

The regional authorities, principally the Northwest Development Agency, have funded the CCAP process. The recent involvement of the Agency in the Interreg IVC GRaBS project has provided additional funding that has been targeted specifically at developing capacity around green and blue infrastructure adaptation responses.

Can it have an impact?

The strong regional policy framework emphasising the role of green infrastructure in adaptation to climate change has supported the CCAP and the implementation of related actions. In addition, the Natural Economy North West project [8] highlighted significant economic benefits of green and blue spaces. These factors have helped green infrastructure to become established as a key element of spatial planning in the region. It is also significant that the organisational structures set up by the Community Forests North West mean that Northwest contains England's most comprehensive network of academics, practitioners, funders, policy makers and planners focused on green infrastructure. This group can provide the necessary advice and help for local authorities in developing practical solutions for adaptation to climate change using green and blue infrastructure approaches.

Indeed, over the past two years there has been significant progress on the implementation of the Northwest England's CCAP process. In particular, the evidence base, necessary to implement adaptation actions associated with the use of green and blue infrastructure, has been considerably strengthened. A marked increase in understanding of climate change risk and resilience across both the public and private sector has been observed. Strong partnerships have been developed, supported by topic-based networks including green infrastructure groups. Plans and strategies are being delivered at sub-regional and local level, and the North West is now considered to be a leading English region on climate change [2].

The sub-regions within the North West have been proactive in developing green infrastructure documents. The Green Infrastructure Framework for Greater Manchester [13] and Lancashire Green Infrastructure Strategy [14] are examples of green infrastructure strategies for, respectively, urban and rural areas. Both these documents emphasise links between green infrastructure and climate change adaptation. Production of such documents at subregional scale demonstrates that the actions contained within the regional CCAP are being interpreted to match local conditions and highlight that its principles are being implemented in practice.

However, there remains considerable uncertainty existing around the future of regional governance structures in Northwest England following the UK's parliamentary elections of 2010 and the subsequent change of government. This could ultimately act as a threat, where policy stability is needed to drive long term actions such as those relating to adaptation and green infrastructure. Whether the regional strategy (into which the CCAP is designed to feed) remains a statutory document or not, it will act as a clear statement of regional priorities and principles that could guide local planners and decision makers in their actions on adaptation and green infrastructure.

Additional benefits

The collaborative approach to the CCAP has led to a formation of lasting working relationships between the organisations involved in the process. Developing the CCAP has also increased stakeholder's perception of the compatibility between the objectives associated with the natural environment and economic development in the region. Moreover, the extensive research that led to establishment of a sound database of policies, research and practice associated with the use of green infrastructure in climate change adaptation provides an excellent resource for policy-makers, researchers and general public to use in the future.

Key messages

- Emphasising the potential economic losses associated with not tackling climate change has increased focus on developing adaptation strategies.

- Highlighting the importance of green infrastructure to climate change adaptation in strategic statutory documents at the regional level provided the CCAP with a strong framework and mandate to build upon.

- The region's commitment to providing the 'evidence' needed to influence economic decision makers was successful in raising the profile of green infrastructure.

- Involvement of senior decision makers in the NWDA was crucial for the success of the initiative.

- Setting indicators and targets to establish the trajectory of change in the CCAP at an early stage in the process provided a good way to monitor the achievement of the plan's vision.

- Dividing the broad vision of the CCAP into small, manageable actions each of which was assigned a delivery agent helped to ensure the successful implementation of the actions contained in the plan.

- The impact of individual advocates for green infrastructure, such as the Community Forests Northwest, has been tremendous. Informal groups of key stakeholders (such as the green Infrastructure Think Tank) have also been influential in promoting the concept of green infrastructure in the region.

- There is a strong governance framework in place to take forward adaptation activities in the Northwest region, represented by the NW Climate Change Partnership and, specifically, by the North West Climate Adaptation Group.

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Acknowledgments

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Basel, Switzerland: Building regulations for green roofs

Climate change impacts addressed	High temperatures
Spatial scale	Town or city
Response type	Regulations
Themes driving the initiative	Mitigation of climate change Biodiversity conservation
Factors of success	Leadership or championship Outsourcing research Public engagement Cohesive delivery of multiple benefits

Summary

The city of Basel in Switzerland has the highest area of green roofs per capita in the world. The use of green roofs has been stimulated by a combination of financial incentives and building regulations. Building regulations have required the use of vegetation on roofs since their implementation in 2002. Initiatives aiming to increase the provision of green roofs in Basel were initially driven by energy-saving programmes, and subsequently by biodiversity conservation. The focus on green roofs was promoted by the researchers from the Zurich University of Applied Sciences (ZHAW) in Wädenswil, Switzerland, who worked to influence decision-makers in Basel to amend the building regulations and offer financial incentives to increase green roof coverage.

Case study location

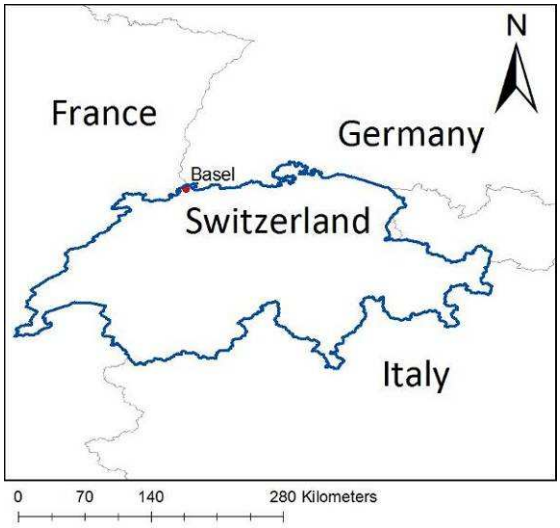

Figure 1. Location of Basel

Located in northwestern Switzerland on the Rhine River and bordering Germany and France, Basel has a population of around 187,000. It is located in the most successful economic region of Switzerland, with the pharmaceutical and chemical industries forming the backbone of its economy. Many major Swiss banks have central offices in Basel, giving finance a pivotal role in the local economy. The City of Basel is one of 26 cantons (states) of Switzerland with its own constitution, legislature and government [(1)].

Basel has a mild climate due to its location in the Rhine valley at an elevation of 277m. It receives Mediterranean air currents and lots of sunshine throughout the year. Winters are characterized by short cold periods, with temperatures between 0 and 5°C. Basel typically has light snow cover for about 25–30 days, which usually does not stay on the ground for more than two weeks at a time [(1)].

There has been a 1.5ºC temperature increase observed in Switzerland between 1970 and 2007. In comparison to the beginning of the 20th century, the frequency of intense rainstorms north of the Alps has increased by between 15 to 70% depending on location. Future climate projections suggest that by 2050s the temperature in Switzerland north of the Alps could increase by 2ºC in winter and 2.5ºC in summer. By 2100, under the high greenhouse emissions scenario, the temperature is projected to increase by about 4.5 ºC in comparison to the 1990s. This means that every second summer will be as hot or even hotter than the temperatures reached during the

2003 heat wave which caused severe loss of life across Europe. Extreme precipitation events are likely to increase in frequency and severity [2].

Development of the initiative

Key aims

The main aim of this initiative is to increase the coverage of green roofs in the city of Basel through the use of a combination of financial incentives and building regulations.

Themes driving the initiative

In many cities of Switzerland, green roofs became popular in the 1970's as an element of ecological construction. Numerous green roofs were created in the 1980s, mainly as pilot projects, which provided a foundation of knowledge and experience for later initiatives. In addition, 1995 was the **EU year of Nature Conservation**. This provided the impetus for Basel's first green roof campaign, which started in 1996 [3].

In the early 1990's the City of Basel implemented a law to support energy saving measures. According to this law, which was the only one of its type in Switzerland, 5% of all customers' energy bills are put into an **Energy Saving Fund**, which is then used to fund energy saving campaigns and measures. The national Department of Environment and Energy decided to pursue and promote green roofs using this source of funds.

Reducing energy consumption of buildings and **protection of biodiversity** have been the key motivators behind expanding green roof coverage in Basel. Initially, the municipality explored green roofs as an energy-saving measure for buildings. Green roofs were funded by the City of Basel for a two-year period in the mid-1990s to stimulate interest and awareness. Encouraged by the success of this project, funds were allocated for a study documenting the biodiversity benefits of green roofs [1]. It is now recognised that green roofs also provide a climate change adaptation function through limiting surface water runoff and reducing temperature in urban areas.

Details of the initiative

The City of Basel has promoted green roofs via a number of funding streams and policies:

- Investment in **incentive programmes**, which provided subsidies for green roof installation. The first incentive programme ran between 1996 and 1997, and was funded from the Energy Saving Fund. This focused on the insulating characteristics of green roofs and their capacity to reduce energy consumption. This was followed by another incentive programme ran between 2005 and 2006, which incorporated design specifications into the green roof guidelines [1].

- The incentive programme spurred interest in research on the biodiversity protection benefits of green roofs [1]. A **grant for research** on the biodiversity protection benefits of green roofs was awarded to researchers at the University of Applied Sciences (ZHAW) in Wädenswil. The research was led by Dr Stephan Brenneisen. The results of this study shaped design specifications for green roofs in Basel.

- In 2002, following the first incentive programme, and incorporating the outcomes of the research into biodiversity value of green roofs, an amendment to the City of Basel's **Building and Construction Law**, was passed (paragraph 72). It reads that all new and renovated flat roofs must be greened [5] and also stipulates associated design guidelines (Box 1).

- **Best looking green roof contest** was held by the city in 1996-1997 and 2005-06 to help promote the green roof incentive programme [3].

Box 1. The green roof regulations [1]

- The growing medium should be native regional soils — the regulation recommends consulting a horticulturalist;
- The growing medium should be at least 10 cm deep;
- Mounds 30cm high and 3m wide should be provided as habitat for invertebrates;
- Vegetation should be a mix of native plant species, characteristic to Basel.
- Green roofs on flat roofs over 1,000 m^2 must involve consultation with the city's green roof expert during design and construction

Implementing the initiative

The two green roof incentive programmes operated for specified two year long periods (1996-1997 and 2005-06). However, the building regulations implemented in 2002 are now an established element of the planning system, and have an ongoing impact (Figure 1).

The incentive programmes were administered by the Canton of Basel [7] and supported by the national Department of Environment and Energy [1]. Due to the semi-independent character of the Swiss cantons in legislative terms, it was possible for Basel's building regulations to be changed at the City level. The development of the regulations was led by the Department of Building and Transport, and included the academic expert in green roofs (Dr Brenneisen) and a group of contractors working in the field of green roofs from the trade association [7]. The installation of green roofs and their maintenance are carried out by the owners of the buildings [7].

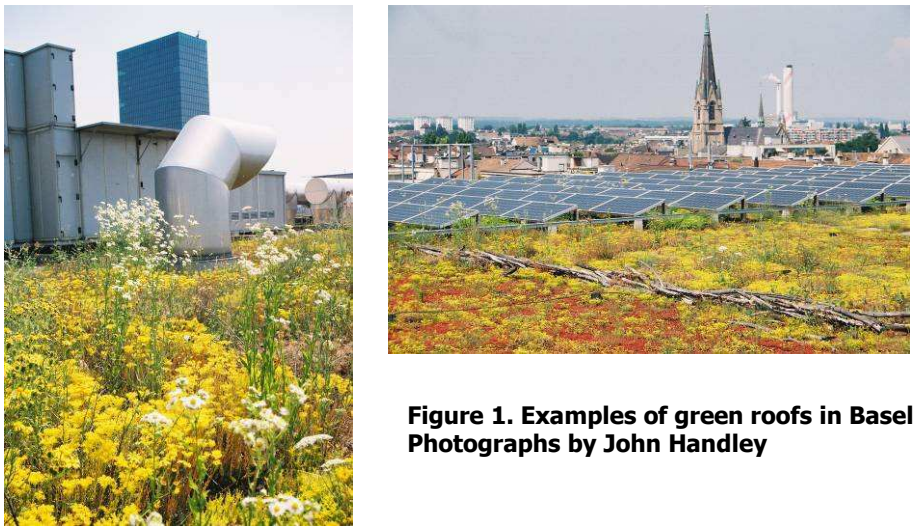

Figure 1. Examples of green roofs in Basel
Photographs by John Handley

Sources of funding

Between 1996 and 1997, the City of Basel invested 1 million Swiss Francs (CHF) in a green roof incentive programme. A further 1 million CHF funded the green roof incentive programme that ran between 2005 and 2006. Finance for these programmes came from the Energy Saving Fund.

The Zurich University of Applied Sciences received funding for a PhD research into the potential of different designs of green roofs to provide valuable habitat for invertebrate species and birds. The outputs of this research supported the development of the evidence base for the amendment of the building regulations [4].

Stakeholder engagement

Prior to the first incentive programme (1996-1997), the Department of Environment and Energy conducted a poll with the Swiss public to determine the level of support for an electricity tax to pay for energy-saving measures. The results of the poll favoured a tax, and the City of Basel then explored energy-saving ideas, including green roofs. In 1996, a variety of stakeholders, including business associations and environmental organizations, were engaged by the City of Basel in the process of developing the green roof incentive programmes [(1)].

The City led on the incentive programme, and the commitment of individuals from the Department of Building and Transport secured the political buy-in for the initiative [(7)]. Various stakeholders were consulted when developing the green roof concept, and in establishing the first incentive programme. They included [(1)]:

- the local business association,
- the horticultural association,
- the green roof association,
- the Pro Natura Basel environmental organization,
- the Department of Parks and Cemeteries in the City of Basel,
- the National Department of Environment, Forest and Landscapes.

Dr Brenneisen's research on green roof approaches to maximise biodiversity played a key role in setting green roof design specifications for the building regulations. Dr Stephan Brenneisen is the head of the Green Roof Centre of Competence at the Zurich University of Applied Sciences Wädenswil, where he conducts research and advises on green roof policies and design[(1)]. Dr Brenneisen has acted as a champion for Basel's green roof programmes.

Basel's green roof regulations did not meet with any significant resistance because all stakeholders were involved in the process from the beginning, and due to the success of the incentive programmes. For developers, installing green roofs is now considered to be a routine practice, and developers make no objections to installing them [(5)].

The incentive programmes were targeted at businesses as well as the residents of Basel. During the incentives programme in 1996-97, the media interest in was high, and newspapers and posters were used to inform residents of Basel about the subsidies [(7)]. This played an important role in its success through increasing awareness of green roofs across a range of stakeholders.

Can it make an impact?

Scope of adaptation

During the first incentive programme (1996–97) 135 people applied for a green roof subsidy, which led to 85,000 m^2 of roofscape being greened. The Building and Construction Law has since provided a major impetus for the development of more green roofs in Basel. In 2006, 1711 extensive green roof projects and 218 intensive green roofs were recorded across the City of Basel in total. Approximately 23% of Basel's flat roof area is now green [(5)]. In 2007, Dr Brenneisen estimated the surface of green roofs in Basel as around 700,000 m^2 [(6)]. It is estimated that through the green roof building regulation, 30 per cent of all flat roofs in Basel will be greened within the next 10 years (Lawler et al., 2006). As Basel now has the highest per-capita area of green roof in the world, the initiatives promoting green roofs can be seen as very successful.

The implementation of the regulations is not considered as problematic. However, the quality of green roofs was not sufficient to provide biodiversity benefits, and this prompted the second campaign and inclusion of the specific requirements relating to quality of green roofs (see Box 1) in the regulations [(7)].

Current work includes awareness raising among the architects, planners, builders, gardeners, and representatives of other professions on the benefits of green roofs [4].

Additional benefits

The biodiversity research conducted in Basel has produced convincing evidence that green roofs can protect endangered invertebrate species [1]. An ongoing study is being carried out to investigate in more detail the ecological benefits of greening the roofs, and the use of roofs as a form of ecological compensation where developments lead to the loss of habitats [4].

Energy savings during the first incentive programme aiming at promotion of green roofs totalled 4 giga watt-hours per year across the City. The amount of energy savings through this second campaign were estimated as 3.1 giga watt-hours per year for the City of Basel [5].

Thanks to the incentive programmes, local business profited from sales of materials and supplies relating to the installation of green roofs, building owners realized energy savings and Basel gained a nationwide and worldwide recognition for its green roof programmes [1].

Key messages

- Green roofs are a type of green and blue space adaptation to climate change that brings multifunctional benefits: while the original entry point was energy-saving, the focus shifted to biodiversity, and then to the role of green roofs in adapting Basel to climate change.
- It is important to involve all stakeholders from the beginning of the initiative to address questions and concerns and ensure that everyone's goals are being met [1].
- Leadership of the project by a committed individual dedicated to the initiative's success.
- A comprehensive suite of mechanisms, from incentives to statutory regulations, has ensured a wide uptake of green roofs in Basel.

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Chicago: Green Permit Program - incentives for developers to install green roofs

Climate change impacts addressed	High temperatures Urban flooding
Spatial scale	Town or city
Response type	Incentive scheme
Themes driving the initiative	Adaptation to future climate Response to current climate Quality of life and attractiveness of place Development need despite climate impacts
Factors of success	Prioritising adaptation Leadership / championship

Summary

Chicago's Department of Buildings (DOB) has developed an incentive program that encourages developers to incorporate environmentally conscious design elements, including green roofs on new buildings. This is known as the Green Permit Program. The incentive is an expedited permit process, through which developers can save both time and money. The initiative is a part of larger portfolio of initiatives aimed at making Chicago's built environment greener and more sustainable. The Green Permit Program was made possible due to the strong leadership of the Chicago Mayor and the efficient processing of the applications by the DOB. Additional benefits of the Green Permit Programme include mitigation of climate change through reduced need for heating and cooling in buildings with green roofs, enhancing the image of the city and the emergence of businesses specialising in green roof installation.

Case study location

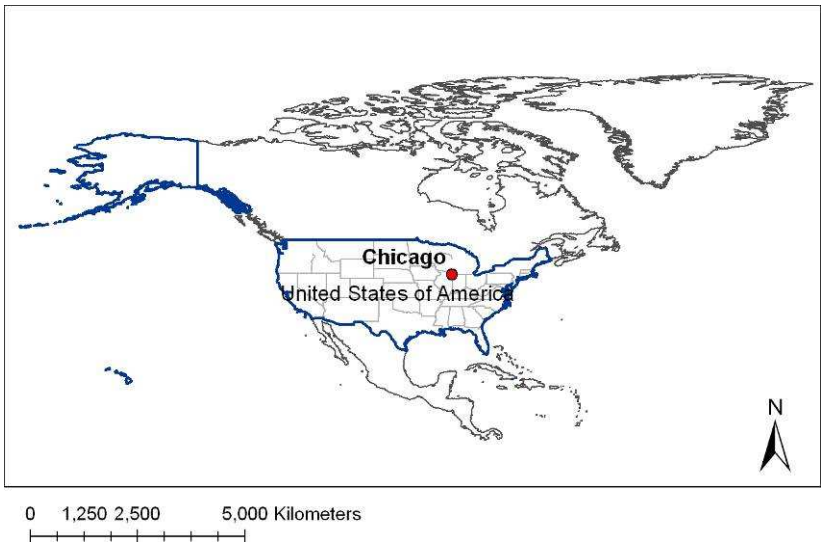

Figure 1. Chicago's location in the USA

Chicago is the third largest city in the United States, with a population exceeding 2.8 million. It sits on the shores of Lake Michigan (Figure 1). A Chicago is a significant transportation and telecommunications hub for North America, and is a major world financial centre with a strong industrial presence. It has the second largest central business district and the second largest workforce in the US (after New York) with approximately 4.25 million workers operating in the metropolitan area.

The current problems associated with weather in Chicago include high temperatures in summer, which frequently result in heat waves. The average July day temperature ranges between 26 and 33ºC, and overnight temperatures are between 18 and 21ºC. In a normal summer, temperatures exceed 32ºC on 17 days. During a heat wave in 1995 the highest recorded temperature was 41ºC [(1)]. This heat wave, combined with high humidity, led to approximately 600 heat-related deaths

mainly of older, poor residents in inner-city areas [2]. Impacts in the Chicago urban centre were exacerbated by an urban heat island that raised nocturnal temperatures by more than 2°C in comparison to surrounding areas [3].

Another problem is urban flooding associated with rainstorms and thunderstorms which commonly occur in the summer. A record-breaking 24-hour rainstorm in July 1996 in south Chicago and its southern and western suburbs killed 6 people, damaged 35,000 homes, and caused evacuation of more than 4,300 people. Losses and recovery costs reached $645 million [4].

Flash flooding and heat waves are likely to be exacerbated by climate change. Temperatures in summer are projected to rise by the end of the 21st century by 5 to 10ºC. In 40 years, more than 40 days per year could exceed 38ºC. Precipitation in winter is projected to increase by 10-25%, and in summer to decrease by 5-20%. Frequency of 24-hour and multi-day downpours causing flooding may increase by 50-150%. Storms are projected to be more severe and have larger impacts [5]. By 2095, Chicago is projected to have the same climate as Texas [6].

Development of the initiative

Key aims

The key aim of the Green Permit Program launched in 2005 is to ensure that new developments in the City of Chicago employ environmentally sustainable, 'green' solutions. The Green Permit Program consists of an expedited development permit process for new building proposals, and also offers a permit fee-waiver for buildings with exceptionally low environmental impact. Items incorporated in the 'green menu' that developers can choose from include green roofs, generation and use of renewable energy, and natural ventilation (see Box 1). In addition commercial, industrial and residential projects must meet the criteria of the Leadership in Energy and Environmental Design (LEED) rating system. The same principles apply to retrofitting buildings as to new builds.

Themes driving the initiative

- **Image of the city**. Chicago has sought to remake itself as "the greenest city in America" through the implementation of a comprehensive environmental agenda that encompasses green buildings, transportation and energy use, and infrastructure and resource management. This strategy is based on linking sustainable or green practices with green economics, improving business prospects, and enhancing quality of life for both residents and visitors.

- **Environmental drivers**
  - **Sustainability of buildings.** Leadership in Energy and Environmental Design (LEED) Green Building Rating System (http://www.usgbc.org/DisplayPage.aspx?CategoryID=19) is the most widely used and accepted standard for green building development in the US. It was developed by the US Green Building Council, which is a national non-profit coalition representing the building industry. In addition to serving as a national standard, LEED is also a certification tool. Points are awarded for design and construction practices and technologies in six categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design. By accumulating points, a building can achieve a rating of LEED Certified, Silver, Gold or Platinum [7].
  - **Stormwater management**. Around 58% of Chicago's urban core is covered by impervious surfaces, causing problems with rainwater runoff [8]. In 2007 the City passed a stormwater ordinance that requires large developments to capture the first half-inch of rainfall on-site. This ordinance has encouraged the installation of green roofs.

- **Climate Change Action Plan** adopted in 2008. One of the actions of the Chicago Climate Change Action Plan is to increase the number of rooftop gardens to total of 6,000 citywide by 2020.

- **Leadership**. The city's green strategy is promoted by Mayor Daley, who has played a very strong leadership role in initiatives related to greening of the city since his election in 1989. For example, Mayor Daley has commissioned the planting of 500,000 trees. In 1995 landscaping began on more than 80 miles of median strips (planters separating two lanes of traffic or pedestrian and vehicular traffic) throughout Chicago. In 2001 the City Hall rooftop garden was opened (Figure 2 and 3). Since 2001, the City of Chicago has constructed 36 green roofs on public buildings totalling more than 100,000 square ft. In addition, all new City of Chicago and Cook County buildings must register for LEED certification and achieve silver standard or higher. In 2005 this led to 22 new city buildings, including fire stations, schools and libraries, being registered for LEED certification. As a result, the design and construction community is gaining experience on LEED projects. As this experience grows, it is beginning to influence private sector development activities [(9)].

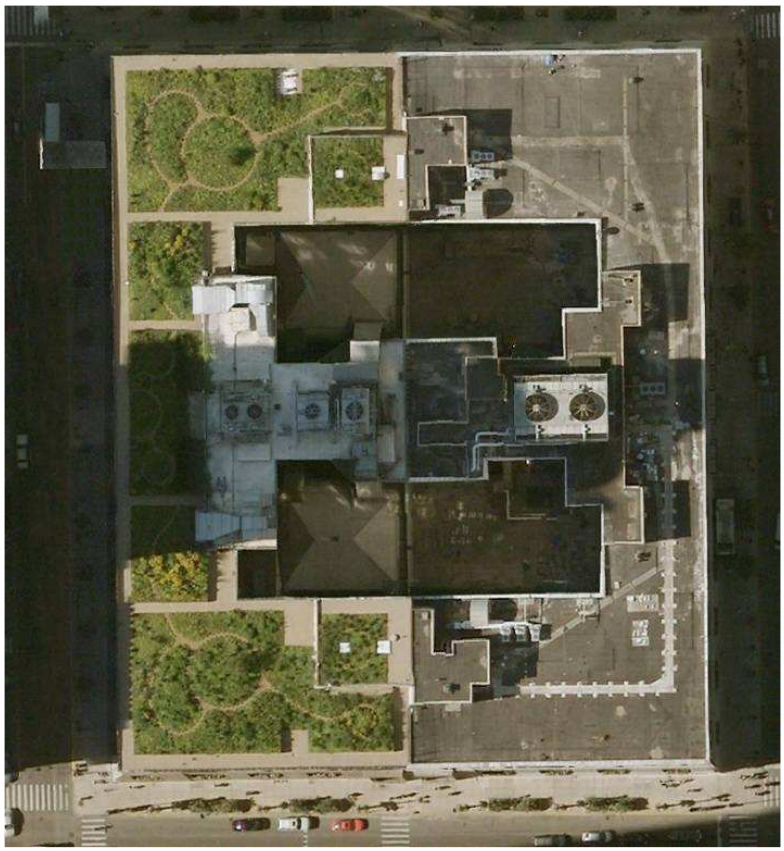

Figure 2. Roof of the building shared by Chicago City Council (left) and Cook County Council (right). The 20,000 square foot green roof, containing 20000 herbaceous plants, 100 wood shrubs, 40 vines and two trees was commissioned by Mayor Daley and completed in 2001 [(10), (11)]

Details of the initiative

To expedite (speed) the permit process relating to gaining planning permission for new buildings, developers must add elements of green building strategy, design and technology to their project as selected from a menu of items created by the DOB (Box 1). Projects admitted into the Green Permit Program can receive permits in less than 30 working days (even just 15 days) rather than within the standard 60-90 days. The more items from the green menu that are included, the shorter the timeline to obtain a permit. In addition, developers who display a particularly high level of green strategy implementation can have review fees waived [(12)].

Box 1. Green Menu Items

- **Green roofs**
- Exceptional energy performance
- Renewable energy
- Extra affordability
- Transit-oriented developments and difficult-to-develop areas
- Innovation
- Exceptional water management
- Exceeds LEED or Chicago Green Homes Certification
- Natural ventilation
- Exceptional bike parking

The requirements for expedited permit and fee waivers differ depending on development's type and size. As an example, an office building over 80feet tall needs to meet the requirements listed in Table 1.

Table 1. The requirements for expedited permit and fee waivers [12]

Benefit tier	Requirements
Expedited permit (goal <30 days)	LEED Certified + 50% green roof + 2 menu items
Expedited permit (goal <30 days) and consultant review fee paid up to $25,000	LEED Silver + 75% green roof + 2 menu items
Expedited permit (goal <30 days) and consultant review fee 100% waived	LEED Platinum **or** LEED Gold + 75% green roof + 2 menu items

The Green Building Permits program is one of a suite of strategies within Chicago's **Green Building Agenda**, launched in 2004, which aims to improve building performance in a changing climate in a comprehensive and flexible manner. The City understood that multiple initiatives must be utilised to address different areas of need, and to accommodate different development perspectives. They include:

- **Green Roofs Initiative**: This is applicable to new public buildings, planned developments and privately funded structures, and is subsidized by the City of Chicago. The initiative promotes green roofs through grants and technical resources. A density bonus, which permits an increased number of units allowed on a piece of property, is offered to developers who cover 50% or 2,000 square feet (whichever is greater) of a roof with vegetation. The City also provides $5,000 in green roof installation grants for small-scale commercial and residential properties. The program has led to the creation of more than 80 green roofs in the city, totalling over 2.5 million square feet. Inducements include 'sticks' as well as 'carrots'. For example, Chicago requires any developer who receives city assistance (for example, to rehabilitate a brownfield site) to include a green roof [13].
- **Green Roof Improvement Program (GRIF)**: This relates to commercial projects in the Central Loop Area (the financial district), which can receive reimbursement grants for up to $100,000 if they meet certain building design conditions. Projects must have a vegetated area that covers more than 50% of the net roof area, include drought tolerant plants (but no monocultures), have a green roof that is highly visible to surrounding buildings, include a minimum two-year maintenance plan for the green roof, and have plans monitor green roof's performance in terms of stormwater management and urban heat island mitigation.
- **Green Homes Program**: The purpose of this program is to encourage residential builders, developers and homeowners to use technologies, products and practices that will increase energy efficiency, provide healthier indoor air, reduce water usage, preserve natural resources, improve building durability and reduce maintenance, and reduce waste and pollution [14].

The City of Chicago also produces best practice management guides that provide information on specific green building topics to developers, contractors and members of the general public. They

include, for example, the Guide to Rooftop Gardening and The Guide to Stormwater Best Management Practices, which recommends green roofs as a measure to manage stormwater. Greening strategies in the city are not limited to buildings. Other initiatives include Greening Chicago's Alleys and Chicago urban forest.

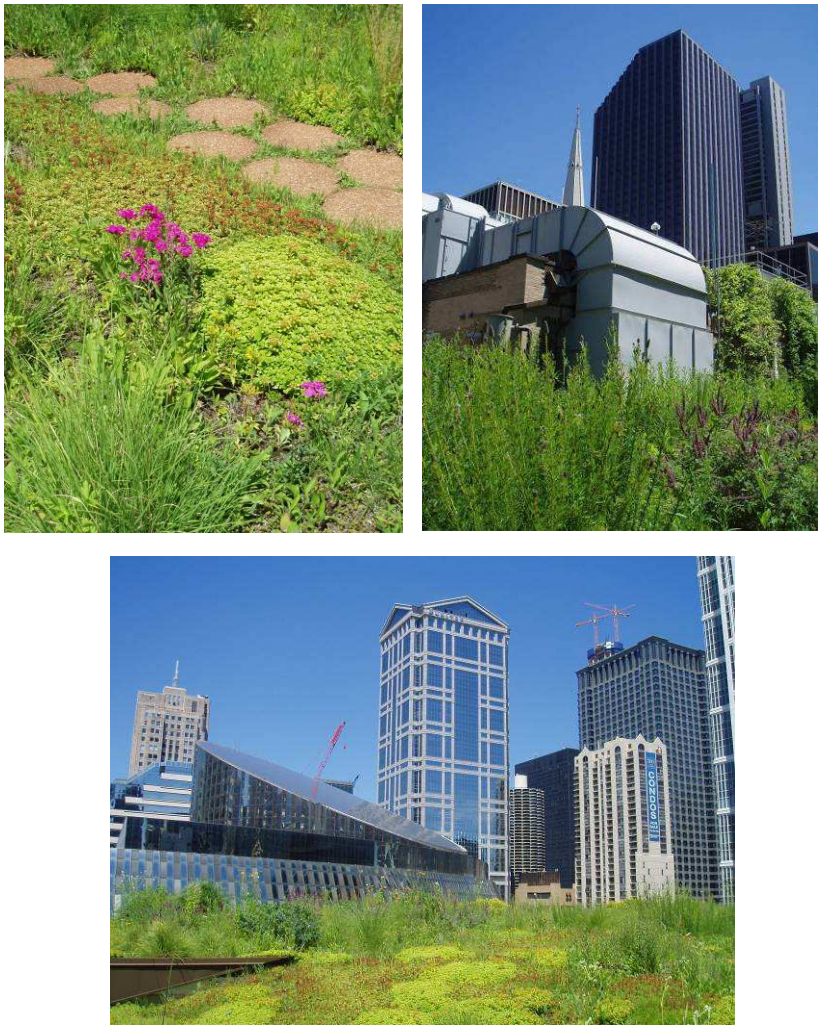

Figure 3. Photographs of the green roof on the City Hall Building in Chicago (Photographs: Aleksandra Kazmierczak).

Implementation of the initiative

The Green Permits Program required adjustments to the planning application process. To participate in the Green Permit Program, the applicant must submit documentation to the DOB outlining the green building components included in their project, preferably once the production of construction documents has begun. These specific components are discussed at an initial Green Permit Program orientation meeting with the DOB team [(12)]. Applicants are then guided through the expedited permit process by a dedicated team of experts in green building design. For details, see the Green Building Process Flow Chart [(15)].

In order to benefit from the DOB Green Permit Program, the applicant must adhere to guidelines, which include actively participating in the review process and responding promptly to issues raised [(12)]. The expedited permit process results in significant savings for developers (Box 2), financial benefits for building owners, and a variety of benefits for the users of green buildings.

Box 2: Financial benefits of Green Permits Program

Expedited process

Development costs can increase by 1-5% to include green features in a new building, compared to standard designs [9]. However, private developers are interested in the time-saving dimension, because they can pay less interest on their construction loans by completing the building and selling it on more quickly. Computer chip manufacturer Intel has estimated that a single day's delay in construction could cost a developer $1 million [9]. Therefore, shortening the permitting process by 3 months on a 22-month project cycle could influence investors when deciding if to proceed with a project. Permitting delays increase tenant costs in both new and existing building**s –** tenants pay higher rents when permitting delays are the norm as the return on investments are also delayed [16].

Building use

- Many variables affect the financial return of green building interventions. 2-20 year paybacks have been observed with substantial savings afterward [17].
- Green roofs cost about twice as much as standard ones, but offer at least double the life span because they are less vulnerable to wear and tear caused by temperature extremes [9].
- A simulation conducted by the City of Chicago of its City Hall green roof showed that every one degree Fahrenheit decrease in air temperature provided by the green roof resulted in a 1.2% drop in cooling energy use and, thereby, in significant financial savings.
- A student halls of residence building at Saint Xavier University cost $300,000 more than a standard building, but its energy costs are expected to be $60,000 per year rather than $90,000 [9].

Impact on users

It was found by a study carried out by the City of Chicago that inclusion of environmentally conscious design in buildings improves staff productivity. For example, sick absenteeism at a police station located in a LEED-certified building was a third lower than in the previous location [6].

Other benefits

- More efficient permit processes may make a city more attractive for investment than other locations. Improved permitting processes can be a cost effective tool in addition to or in lieu of other inducements such as preferential tax rates or regulatory relief.
- Increased construction spending provides broader economic benefits – these benefits include not only employing more construction workers but also purchasing construction related materials and services from local suppliers, creating local jobs, and increased spending at local establishments [16].

Source of funding

The project was funded by the City of Chicago through the DOB.

Stakeholder engagement

The Chicago Center for Green Technology offers tours, workshops and other opportunities for people to learn about green buildings in the city. The Centre's building is LEED-Platinum certified and self-guided tours of the facility are available to anyone who wants to see sustainable design first-hand. Educational workshops on topics of general interest, such as green roofs, are offered to the general public. Seminars designed specifically for industry professionals address issues of interest to them, such as whole-building design strategies. Circa 400 free public programs are

offered each year. The on-site Green Building Resource Center provides reference materials, samples of green building products, and technical assistance seven days a week [7].

Can it have an impact?

The studies on the Chicago City Hall green roof indicate that on a typical day in August (32-35ºC) the City Hall green roof is cooler than the air temperature, while the roof on Cook County side of the building, which is covered in blacktop (see figure 2), can reach a temperature of 66ºC. Therefore, green roofs can significantly reduce the heat island effect. Further, the green roof on the Chicago City Hall Building retains more than 75% of water produced by a one-inch storm, preventing this from reaching the combined sewer system therefore reducing flood risk. Studies show an overall 50% reduction in total stormwater runoff from this green roof [8].

Surprisingly, Chicago, which is one of the leading jurisdictions in green roof policy, does not have accessible up-to-date database of green roof installations [18]. The estimated area of green roofs in Chicago is 49,655 m² in 2008 (according to Green Roofs for Healthy Cities; http://www.greenroofs.org/resources/GRHC_Industry_Survey_Report_2008_Media_Release.pdf). The City issues approximately 50,000 building permits a year. Even if a fraction of these developers applied for green permits, the cumulative impact of the regulations on climatic factors (temperature and precipitation) would be significant. Many businesses in Chicago are pursuing green development; not only residential and office buildings but also museums, restaurants, hotels and real estate management companies. The success of the initiative is highlighted by the fact that Chicago has more green roofs built or under construction than any other North American city [10]. In October 2006 there were 250 private and public green roofs in Chicago. By 2008 this number had risen to 400 (see the interactive map of green roofs; http://www.artic.edu/webspaces/greeninitiatives/greenroofs/main_map.htm). The Chicago Climate Change Action Plan sets a target of 6,000 green roofs by 2020 [10].

Moreover, the benefits of the initiative reach beyond the City of Chicago, as other metropolitan areas in the USA have followed Chicago's example. These cities include Portland in Oregon, San Francisco and New York [20].

Additional benefits

The green roof effort has also stimulated business development. Indeed, there are now more than 24 green roof companies in Chicago.

The installation of green roofs results in the reduction of carbon dioxide emissions, and also lowers energy costs associated with cooling and heating of buildings. A simulation by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) conducted for the green roof on the City of Chicago Hall showed that every one degree Fahrenheit decrease in ambient air temperature within the building results in a 1.2% drop in cooling energy use. The study suggests that if, over a period of ten years or more, all of the buildings in Chicago were retrofitted with green roofs, (30% of the total land area), this would yield savings of $100 million annually from reduced cooling load requirements in all of the buildings in Chicago [19].

Key messages

- The case of Chicago shows that innovative, bold solutions to development planning work. The increase in green roofs has been achieved through an incentive programme for developers, illustrating the effectiveness of solutions where mutual benefits are achieved (see also Faenza,

Italy). Finding a solution that is easy to understand and financially feasible for both public and private sector is crucial (Box 3).

- Strong leadership from the city mayor secured the success of the programme. An influential figure or organisation leading an initiative helps to drive its success (compare with the England Northwest case study, where an NGO and a regional authority led the climate change action plan).

- The vision of a "greenest city on America" stimulated action. Similarly, the City of Nagoya strives toward the status of Environmental Capital of Japan.

- Anything required of the private sector is tested and piloted first within the public sector. By championing green development practices, the public sector is helping to set the standard for others to follow.

Box 3: Key factors influencing the success of financial incentives [21]

- Key stakeholders need to agree on clear, specific, measurable environmental objectives.

- Given agreement on performance objectives, developers responsible for implementation should have the freedom to design plans that lead to meeting the programme's objectives. Successful programmes mandate performance goals rather than technology.

- Clear procedures should be established for open stakeholder participation in the design and implementation of programs. At the same time, these processes need to be linked to the achievement of program objectives.

- Incentives for participation in programs of this kind need to be tangible and significant

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London Borough of Sutton: Adaptation to flooding via local planning policies

Climate change impacts addressed	River flooding Urban flooding
Spatial scale	Town or city
Response type	Policy
Core drivers	Response to current climate Adaptation to future climate Quality of life and attractiveness of place Development need despite climate impacts Higher-level policy framework
Good practice	Prioritising adaptation Internal collaboration External collaboration Outsourcing research Sound evidence base

Summary

The London Borough of Sutton, a local planning authority located in the South East of England, has prepared a range of innovative spatial planning policies that seek to ensure future development within Sutton is fully adapted to the impacts of climate change. Whilst impacts such as temperature rise and occurrence of heat waves are also covered by these policies, this case study focuses on how spatial planning policies have been developed to address the risk of all forms of flooding to and from new developments, and to promote the role of sustainable urban drainage systems in managing surface water runoff. Flooding has already caused significant damage in parts of the Borough, and climate change is projected to further increase the frequency and intensity of flood events. The case of Sutton offers valuable lessons on the development of planning policies targeting adaptation to flooding. These include the use of a robust evidence base to develop policy, and the engagement of local stakeholders and residents in the planning process.

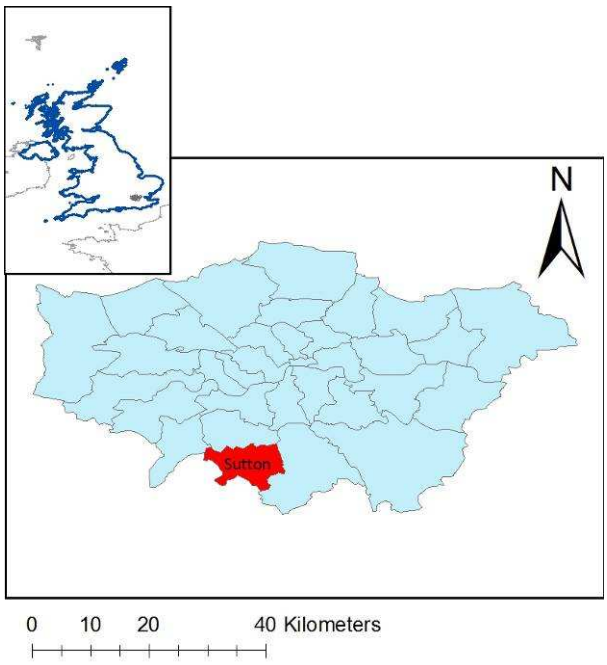

Figure 1. Location of Sutton in the UK and in Greater London

Case study location

London Borough of Sutton is a local authority with planning powers in the Greater London Area, South East of England. Sutton covers 44 km^2 and has a resident population of more than 187,000. The Borough forms an important part of the Wandle Valley, the key regeneration corridor within South London. Although the Borough is mostly suburban in nature, certain locations, including Sutton Town Centre and Hackbridge, are identified as areas of 'sustainable regeneration and growth' in Sutton's Core Planning Strategy (their key spatial planning document). Such areas will be the focus for significant redevelopment over the next 10-15 years, particularly for residential and commercial uses. Sutton Town Centre is expected to accommodate around 40% of the Borough's planned housing growth over this period with the Hackbridge sustainable suburb accommodating a further 20%.

The Borough is affected by a number of different sources of flood risk, including fluvial (river) flooding, surface water flooding, sewer flooding and groundwater flooding. Within the context of projections for changes in the UK's climate, the extent of these risks is expected to increase. Approximately 5% of the land area in Sutton is at medium risk of river flooding (between 1% and 0.1% annual probability) and a further 5% lies within either high risk areas (over 1% annual probability) or on functional floodplain. Consequently, 5% of properties within the Borough are at risk of fluvial (river) flooding. The catchment area of the main watercourse, the River Wandle, is highly urbanised. Up to 80% of its floodplain has been already developed, in many locations right up to the edge of river channels. As a result, the Wandle catchment rapidly responds to precipitation, with the risk of surface water, sewer and fluvial flooding occurring within minutes of heavy rainfall events [(1)].

Between January 1998 and December 2008 there have been 35 events of heavy rain and flooding which have caused significant damage in Sutton [(2)], the two most significant events being 15 September 2000 (58mm) and 20 July 2007 (over 40mm). During the latter event the rainfall volume exceeded the design capacity of water drainage systems and watercourses at multiple locations and caused damage to at least 52 council properties as well as widespread damage and disruption for householders and transport systems.

The frequency and severity of heavy rainfall events within London is expected to increase further under the changing climate. Under the medium emissions scenario from the UK Climate Impacts Programme, by the 2080s the number of days with rainfall greater than 25 mm is likely to increase by 100%-250% in winter and by up to 100% in summer. The risk of exceeding of the urban drainage system and surface water flooding is therefore likely to increase into the future unless further adaptation measures are taken to manage and reduce this form of flooding

Development of the initiative

Key aims

The aim of the initiative has been to ensure that the Council's policies on climate change adaptation and flood risk included in spatial planning documents guiding future development within the Borough avoid, reduce and manage flood risks while promoting the multi-functional benefits of green and blue infrastructure. High housing targets set by the national government mean that Sutton cannot avoid new development in flood risk areas. In addition, new UK Government legislation introduced since the severe national flooding events of 2007 requires local authorities such as Sutton to play a clear leadership role in local flood risk management by promoting partnership working with key stakeholders [(3), (4)].

Themes driving the initiative

- **Statutory national policies**. The inclusion of climate change adaptation policies in Sutton's spatial plans has partly been driven by national level Planning Policy Statements (PPS). The Supplement to PPS1: Planning and Climate Change [(5)] requires that new development is secure, minimises the vulnerability and provides resilience to climate change. PPS25: Development and Flood Risk [(6)] seeks to ensure that where new development cannot take place anywhere else than in flood risk areas, it must be made safe, without increasing the flood risk elsewhere. Sustainable Urban Drainage (SUDS) measures are promoted in order to ensure that surface water runoff rates do not increase following redevelopment, including an allowance for climate change.

- **Regional strategies.** The Mayor's London Plan [(7)] sets out a range of policies addressing flood risk management and climate change adaptation, which form part of the development

plan for the London Borough of Sutton. Application of SUDS in order to minimise run-off from development sites to municipal drainage systems or watercourses and protecting and enhancing green infrastructure are promoted. Greater London Draft Climate Change Adaptation Strategy [8] advocates "urban greening" for climate change adaptation.

- **Borough strategies and initiatives**
  - **"One Planet Living"** Sutton was the first UK council to adopt "One Planet Living" [9], which is a global initiative developed by BioRegional and the World Wildlife Fund (WWF) to promote more sustainable council services, lifestyles and workplaces. The initiative has raised awareness of climate change among residents and enjoys widespread support from the local community. As part of the Vision for Sutton of a 'One Planet Living' Borough by 2025, the Council is piloting the regeneration of Hackbridge as the UK's first sustainable suburb. This is reflected in Sutton's adopted Core Planning Strategy. One particular goal of "One Planet Living" is to turn Hackbridge into the UK's greenest place to live.
  - **LiFE project -** Long-term Initiatives for Flood-risk Environments [10], led by Building Research Establishment and funded by the Department for Environment, Food and Rural Affairs within the "Making Space for Water" programme [3]. This project sought to demonstrate how towns and homes can be better prepared for a more unpredictable short term future, whilst reducing long term environmental impact. Hackbridge was chosen as one of three UK pilot studies to consider how to integrate natural flood mitigation with ecological development proposals while incorporating best practice in spatial planning. The outcome the LiFE study, the 'masterplan' for Hackbridge, identifies a range of flood risk and other climate change adaptation measures, including green and blue space approaches.
  - The London Borough of Sutton has adopted **National Indicator 188** (NI188) "Planning to Adapt to Climate Change." NI188 forms part of the Local Area Agreement (LAA) which outlines the Borough's key priorities. In line with NI188 requirements, the Council has recently undertaken a comprehensive audit of Council strategies, policy documents and business plans to provide a broad overview of how weather and climate issues are currently integrated into council plans and strategies.
  - **GRaBS project** – Green and Blue Space Adaptation for Urban Areas and Eco Towns [11]. Participation of Sutton in the GRaBS project ensured a firm focus on green and blue spaces in adaptation to climate change. The aim of the project for Sutton is to develop the Climate Change Adaptation Plan for the area of Hackbridge.

- **Floods in 2007.** The severe flooding events of July 2007 affected many parts of the country, including the London Borough of Sutton, and raised awareness of the need to protect against or adapt to flooding. Sutton was one of the worst affected London Boroughs with 44mm of rain recorded on the morning of 20 July 2007. The London Borough of Sutton established a cross-departmental Flood Group in response to these events.

Details of the initiative

In England and Wales spatial planning is delivered by local authorities. Each local authority produces a **Local Development Framework** (LDF), which is a suite of documents setting out the spatial strategy and policies for the development and other use of land in the local authority's area (Figure 1). In Sutton, policies on adaptation to climate change using green and blue spaces have been included in several LDF documents. Collectively these policies provide a framework and context for significantly strengthening the role of spatial planning policy in adapting Sutton to climate change impacts.

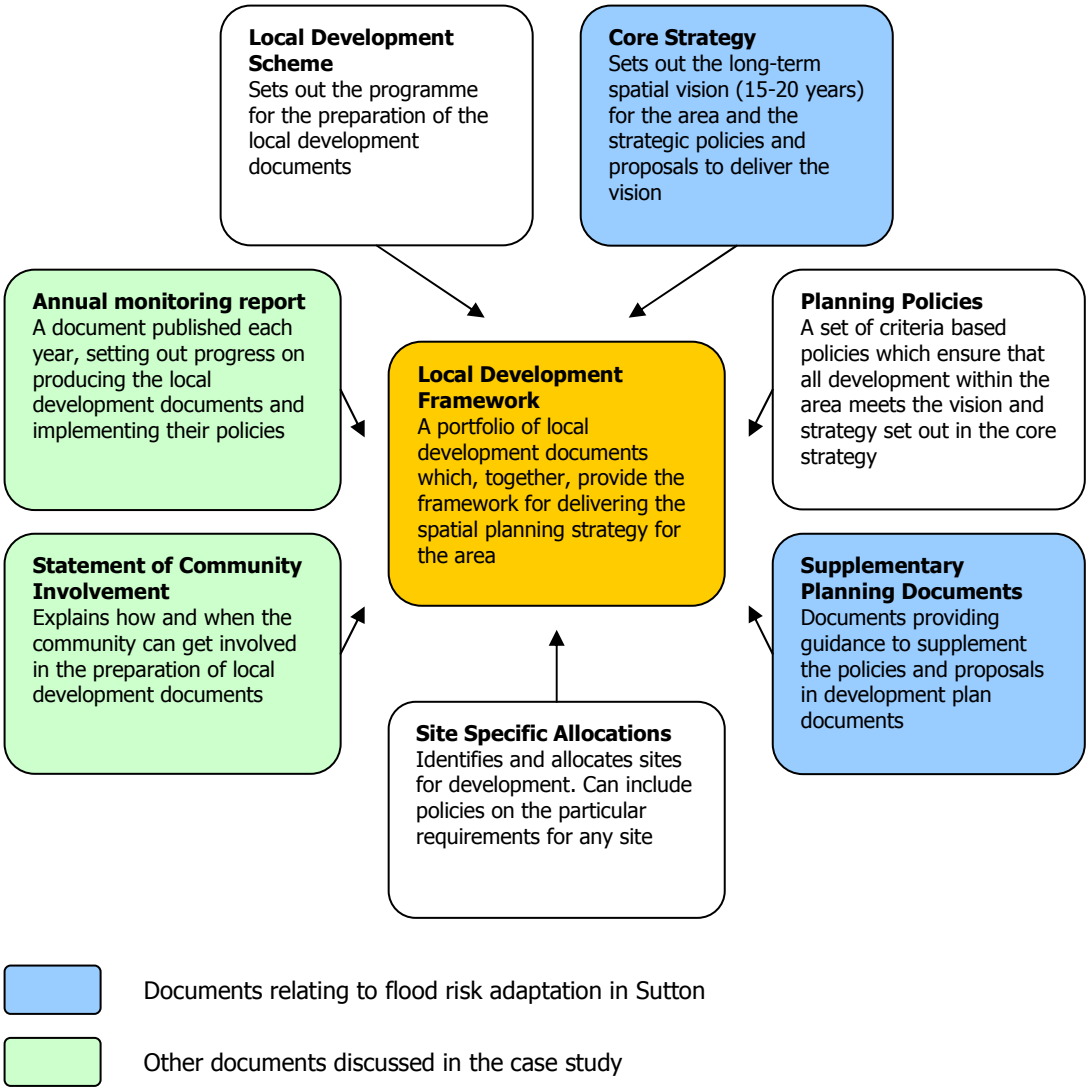

Figure 2. Documents forming Sutton's Local Development Framework

The overarching **Sustainable Communities Strategy**, which covers the period 2008-2020, is the "plan of plans" developed by local authorities in collaboration with their stakeholders (see stakeholder engagement section). Sutton's Sustainable Communities Strategy [(12)] recognises that:

"Climate change is one of the most significant long-term issues facing the borough."

Consequently, adaptation to climate change influences the shape of other documents in the LDF:

- **The Core Planning Strategy** (adopted December 2009) is the most significant development planning document prepared by the Council and sets out a long-term vision for Sutton. Specific objectives reference climate change adaptation issues. Strategic Objective 6 is

  "to achieve the highest standards of sustainable design and construction in all new developments by addressing climate change impacts and minimising flood risks (…)."

  Strategic Objective 7 is

  "to ensure that new development is not exposed to unacceptable risks of flooding and avoids, manages and reduces the potential risks of flooding elsewhere, taking into account climate change."

Core Policy BP7 on Flood Risk and Climate Change Adaptation reads that:

"the Council will seek to avoid, manage and reduce all sources of potential flood risk to and from new development by (…) promoting the most effective adaptation to the impacts of climate change as part of new development, including SUDS (…)"

- Supplementary Planning Documents supporting the Core Planning Strategy that include policies on adaptation to floods via green and blue infrastructure are:

  - **Site Development Policies**: **Proposed Submission Document** (approved December 2009; Figure 3). This document identifies a range of sites to meet the development needs in the Borough and puts forward policies for controlling and managing new development. These include policies guiding sustainable design and construction that aim to reduce flood risk and enhance climate change adaptation measures, and policies specifically targeted at reducing flood risk to and from new developments (via SUDS and green and blue infrastructure). In addition Policy DM8 on Climate Change Adaptation emphasises that:

  "The Council will promote effective adaptation to the impacts of climate change within the Borough by ensuring that the location, layout and design of all developments: (…) maximise the role of blue and green infrastructure for flood storage and mitigation."

  The document notes that wherever practical developers should give consideration to various types of SUDS involving green roofs or walls; wetlands, swales and infiltration strips mimicking natural drainage patterns; basins and ponds to hold excess water after rain and allow controlled discharge; and retention of mature trees and soft landscaping in front gardens and other means of reducing the amount of impermeable surfaces.

  - **Sustainable Design and Construction Interim Planning Guidance (IPG).** Guideline SDC8 on 'Climate Change Adaptation' states that:

  "the Council will require all development proposals to take account of the expected changes in local climatic conditions throughout the lifetime of the development, through the incorporation of adaptation measures or sufficient flexibility of design to allow for future adaptation, including measures to: (…)
  - *reduce flood risk by applying principles of SUDS;*
  - *protect and enhance green infrastructure."*

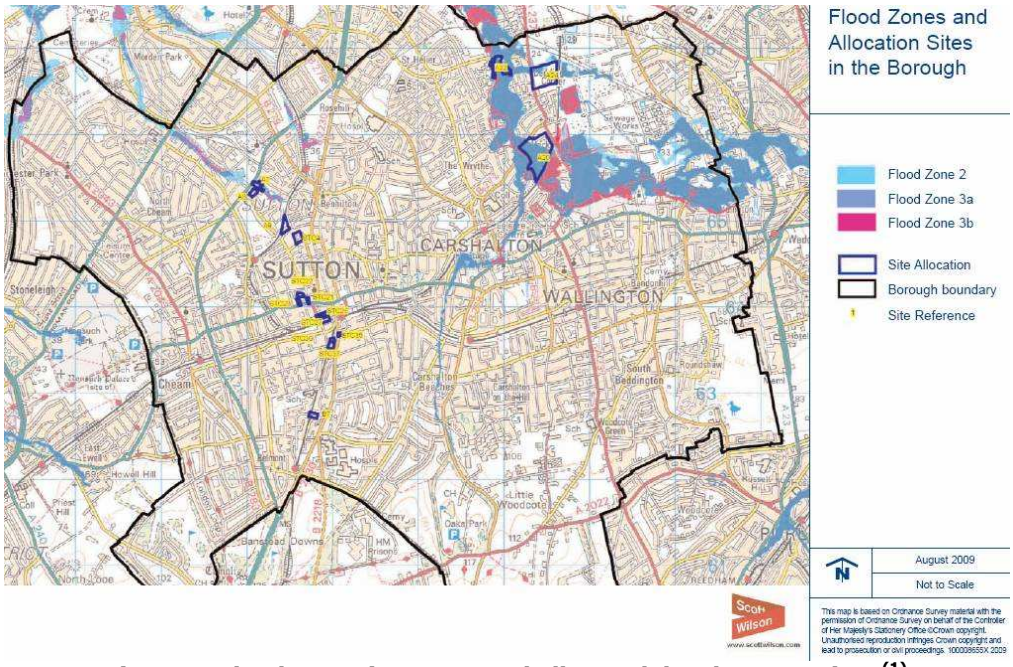

Figure 3. Flood zones in Sutton and allocated development sites [(1)]

- **Sutton Town Centre Area Action Plan** (at public consultation stage) identifies suitable sites for development and redevelopment in the town centre. This notes that all town centre development should demonstrate that flood risks are safely managed, which can be achieved through measures such as green roofs and soft landscaping.

- **Hackbridge master plan** states that it is important to slow rainwater runoff by increasing porous surfaces (on roofs and at ground level), collecting rainwater for re-use or controlled release to the sewers, and increasing vegetation. Green roofs and green spaces can also be used as means to improve biodiversity or as a community amenity.

Implementation of the initiative

The LDF process is driven by local authorities, and in Sutton the LDF is delivered by the Strategic Planning team. The LDF process began in 2005 and is ongoing, with adoption of all policies planned for 2011. The process is closely regulated by national policies (in particular PPS 12: Local Spatial Planning) and legislation. These policies emphasise the importance of stakeholder engagement in LDF preparation.

The "silo" character of local authorities, where there can be little cross-departmental information exchange, is a problem when tackling a complex problem such as climate change adaptation. In Sutton this was solved by the establishment of a multi-departmental **Flood Group** following the floods in 2007. The group included representatives from the departments of planning, environment, emergency planning, highways and external parties (see stakeholder engagement section below). This group created a platform for data sharing between different departments of the local authority and helped to ensure that climate change adaptation was one of the significant issues driving the development of LDF.

Building the evidence base

Local Development Frameworks, according to national policy on spatial planning, must be evidence-based. Some data on climate change and related risks is available from the UK Climate Impacts Programme to assist local authorities when preparing their planning strategies. However, in Sutton's case, a large amount of additional information was collected especially for the purpose of preparing the LDF. This included a **Local Climate Impact Profile** [(2)] exercise which investigated the frequency and severity of weather-related events, including floods, between 1998 and 2008. Also, in order to comply with PPS 25, Sutton undertook a **Strategic Flood Risk Assessment**, which provided a better understanding of climate change and flood risk. The Council has recently commissioned consultants (Scott Wilson) to undertake a Borough-wide surface water management study to provide a detailed assessment of surface water, sewer and groundwater flood risk in the Borough.

To support decision-making, planners in Sutton have also drawn on existing good practice examples, such as the handbook produced by the UK Town and Country Planning Association "**Climate change adaptation by design**" [(13)]. Engagement in research projects also helped the authority to learn about possible adaptation approaches.

Monitoring and evaluation

- An **annual monitoring report** is produced each year to measure progress against defined indicators, such as the number of planning permissions granted contrary to Environment Agency (statutory body providing advice to local authorities on flood risk) advice on either

flood defence or water quality grounds, and completed residential developments located within medium and high flood risk zones and on functional flood plains.

- **Sustainability Appraisal** is a compulsory process that highlights the potentially significant environmental, economic and social impacts of spatial plan implementation. In Sutton the Sustainability Appraisal was carried out at very early stages of LDF development, and helped to identify gaps in policies. As a result of the process a number of indicators were established to report the progress of the LDF against sustainability objectives. One of the indicators concerns whether developments are adapted to future climate change scenarios.

- **Code for Sustainable Homes – Level 3** [(14)]**.** The Code for Sustainable Homes requires that rainwater storing facilities or sustainable drainage is used in new developments to ensure that the peak run-off rates and annual volumes of run-off are no greater then the previous conditions for the development site. Adherence to this code will be monitored.

- **National Indicators (NI)** are used by the Government to assess the performance of local authorities. Each local authority, alongside 16 statutory indicators, selects up to 35 from the list of 198 NIs against which their performance is measured. Sutton has included NI 188 - adaptation to climate change - and NI 189 - flood risk management – in their list.

Stakeholder engagement

Collaboration with key stakeholders

Whilst Sutton Borough Council has been leading the work on preparing the LDF, a number of different stakeholder groups have contributed to its development to help ensures the vision for Sutton's development is a shared one meeting the needs of a wide range of relevant stakeholders.

- The Local Strategic Partnership (**Sutton Partnership**) developed the Sustainable Communities Strategy guiding the LDF. Sutton Partnership brings together public sector organisations (the council, the police and the primary care trust), private organisations (e.g. local businesses) and voluntary and community organisations.

- **The Flood Group** facilitated the inclusion of policies related to flooding in the LDF. Alongside representatives of different departments from within the local authority, the Flood Group includes water and sewerage providers (Thames Water and Sutton and East Surrey Water) and the Environment Agency (national agency responsible for flood protection).

- Key stakeholders participating in sustainability workshops run within the **Sustainability Appraisal** process. This enabled key stakeholders to input into the assessment of different aspects of the LDF, and helped the local authority to develop closer links with these groups.

- Neighbouring Greater London Authorities. The Strategic Flood Risk Assessment, compulsory for all local authorities, was carried out jointly for four **London Boroughs: Sutton, Croydon, Merton and Wandsworth,** which are all located within the Wandle catchment area. This initiative has supported cross-boundary working between different local authorities on flood risk issues, helping encourage a joined-up approach to flood risk management across the catchment.

Engaging the public

Public participation in the planning process is regulated by the compulsory borough-wide **Statement of Community Involvement** (adopted by Sutton in July 2006) that details how the Council will involve the community in planning matters. The residents of Sutton have been

involved in extensive consultations over recent years on all LDF documents (see Box 1). Four distinct stages are included in consultation of development planning documents. These are:

- Issues and options, which involves early consultation on issues that the Core Strategy needed to address and the range of available options to address these issues.
- Preferred options, which involves further public and stakeholder consultation on the Core Strategy following the issues and options consultation.
- Submission, which involves consultation on the final version of the Core Strategy after consideration of comments made at Preferred Options stage.
- Examination, which considers if the development plan document (DPD) is sound. An inspector is appointed by the Secretary of State to conduct the Examination. The Inspector produces a report with recommendations that are binding upon the Council. This stage can be carried out in public, in the form of a round table discussion and hearings on specific issues.

Box 1. Public consultation of Sutton's Core Strategy

Notices about the consultation process were put in local newspapers. Leaflets with information about the consultation were then sent to key stakeholders, residents' groups, local businesses and other parties who had previously expressed a view or were known to be interested in planning matters in the Borough. Copies of the document and a questionnaire key Core Strategy issues were made available for public inspection in local libraries and on the Council's website.

This was followed by four area-based community workshops and presentations to local community groups. These included established groups with an interest in sustainability initiatives and nature conservation, in particular focusing around the River Wandle. Finally, efforts were made to engage hard-to-reach communities, such as ethnic minorities, by using community champions as intermediaries.

Political buy-in

Elected local Councillors have played a pivotal role in the strategic planning process and provided political support for climate change adaptation initiatives. All policy documents are reviewed by selected Councillors, who make a recommendation to the Council leaders who are responsible for the final approval of the policies.

Sources of funding

The development of spatial planning frameworks for the local authority was funded by the London Borough of Sutton. The key elements requiring funding were the reports on flood risk and the local climate impacts profile, which were prepared for Sutton by external consultancy companies.

Can it have an impact?

Scope of adaptation

The importance of national and regional policies that acted as key drivers for the inclusion of climate adaptation in local planning cannot be underestimated. There is a danger that the policies at the local level will only provide 'lip service' to national and regional requirements. However, the strong commitment of the London Borough of Sutton to make policies work and to strengthen the capacity of the area to adapt to future impacts of climate change has proved to be crucial in avoiding this danger. This is shown, for example, by inclusion of NI 188 and 189 as indicators that Sutton will use to assess its performance for central government reporting purposes.

The LDF policies in Sutton present a coherent approach to adaptation to floods. The importance of the climate change problem is highlighted in the Sustainable Communities Strategy, and the Core Strategy formulates the general course of action to tackle adaptation issues. Supplementary Planning Documents then stipulate what adaptation measures should be used by developers.

The inclusion of adaptation approaches to flooding within Sutton's planning policies has the potential to considerably affect the form and function of new development sites. Furthermore, emphasis on these measures in the Hackbridge masterplan and the Sutton Town Centre area action plan has the potential to add an adaptation dimension to areas undergoing redevelopment. However, existing buildings and sites are not controlled by spatial planning policy, which limits the impacts of these policies to new development and areas being redeveloped.

Additional benefits

The inclusion of green and blue spaces in local development can help Sutton adapt to rising temperatures and the urban heat island effect, and the Borough's adaptation policies also cover these impacts (although the focus of this case study is on flooding). In addition, green and blue spaces provide recreational amenities, improve local residents' quality of life and enhance biodiversity, and hence their use in new developments is likely to result in additional benefits.

Involvement of key stakeholders in formulation of the policies within the LDF raised the profile of adaptation using green and blue infrastructure. Establishment of the interdepartmental Flood Group increased awareness of spatial planning's role in adaptation to climate change. Moreover, involving stakeholders from outside the Borough Council in the Flood group has also helped to increase adaptive capacity within the area through awareness raising of relevant issues. Therefore, both the implementation of adaptation measures and future work on adaptation to climate change are likely to benefit from experiences gained in preparing the LDF.

Participation in the creation of the LDF has helped to ensure that the public is well informed, and that implementation of initiatives involving green and blue infrastructure will be met with less resistance. Further, the general empowerment of local residents brings a variety of social benefits.

Key messages

- Early engagement with stakeholders via the Local Strategic Partnership was crucial to securing the Sustainable Communities Strategy in a form acceptable to a range of groups.
- Assessments undertaken at an early stage of the preparation of the Local Development Framework (through the Sustainability Appraisal process) allowed identification of gaps in, and subsequent modification of, Sutton's planning policies.
- Setting up an inter-departmental working group improved data sharing and made work on complex policies (in this case relating to flooding) easier.
- The engagement of research institutions' and consultancies' expertise was helpful for establishing an evidence base and making informed decisions.
- Engaging in research and pilot projects provided Sutton with access to good ideas and support relating to adaptation issues.
- Sutton benefited from the use of good practice examples and guidance, such as the "Adaptation by Design" guidance on climate change adaptation produced by the UK Town and Country Planning Association.
- Requirement for introduction of adaptation measures in existing development would be valuable given the slow turnover of building stock in urban areas, but this is beyond the scope of the spatial planning system and needs to be achieved through other mechanisms.

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Acknowledgements

Many thanks go to Patrick Whitter for his help in completing this case study.

Nagoya: Adaptation to climate change driven by biodiversity conservation

Climate change impacts addressed	High temperatures Urban flooding Drought
Spatial scale	City
Response type	Policy
Core drivers	Adaptation to climate change Mitigation of climate change Biodiversity conservation Quality of life and attractiveness of place Sustainable but intensive urban development Water management Higher-level policy framework
Good practice	Prioritising adaptation Internal collaboration Public engagement

Summary

Changes in land use associated with industrialisation and the expansion of residential areas have reduced green sites in Nagoya to about 25% of the area of the city. An additional cause of concern is the increase in temperature of Nagoya City associated with climate change. These factors are exacerbating the urban heat island effect and problems associated with high temperatures in the urban areas of Nagoya. Given these threats, the City of Nagoya has undertaken various measures to create more sustainable lifestyles in the city. The main initiative that can help the city become better adapted to climate change (in particular to high temperatures) is the 2050 Nagoya Strategy for Biodiversity, which aims to improve and extend the green areas of the city. Sitting within the Biodiversity Strategy, the Water Revitalisation Plan aims to recharge ground water supplies by increasing infiltration through the use of green spaces. A crucial aspect of the Biodiversity Strategy is its implementation in close collaboration with the city's residents, business and non-governmental organisations.

Case study location

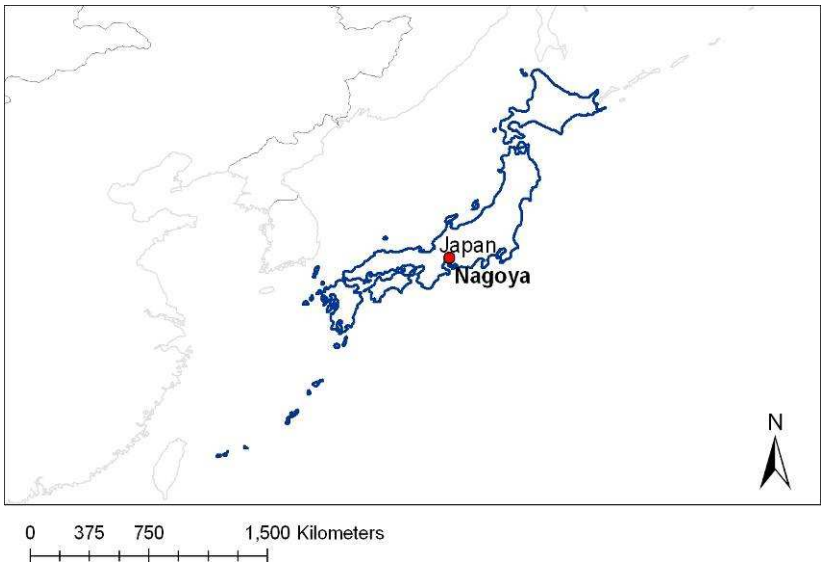

Figure 1. Location of Nagoya

The City of Nagoya is located on the Nobi plain on the Pacific coast of Japan. It covers an area of 326 km^2 and includes diverse landscapes ranging from hilly areas to the east and the central plateau, to the alluvial plains and reclaimed lands in the north, west and south. The city was established as a castle town in 1610, and has developed a strong manufacturing industry over recent decades and is now one of the most important ports in Japan. Nagoya's population currently numbers approximately 2.2 million (density of population 6903 people/km^2), and it is the fourth largest Japanese city [(1)]. The city

aims to become sustainable through the transformation to a low-carbon economy, by promoting co-existence of people and nature, and by recycling of natural resources [(2)].

The city has a warm and humid climate, with an average annual temperature of around 16º degrees Celsius, with a minimum of -3.7ºC and maximum of 37.5ºC. The average annual rainfall (1976–2005) is around 1600mm [(3)]. Over the last 100 years, the average temperature has risen by approximately 2.7 ºC, which is roughly 3.5 times the global average. In addition, the frequency of intense, localised rainfall events has increased since the 1970s. Events of over 50mm rain per hour are now 1.6 times more frequent, and events of over 100mm per hour are now 2.3 times more frequent. This means that the city (in particular areas below sea level) is vulnerable to flooding and the management of runoff and drainage is consequently a problem [(4)].

Nagoya has about 8,800 hectares of green space (24.8% of the total city area) [(4)]. Green space has significantly decreased in recent years due to the development of industrial zones along the coast and on reclaimed land, and through the loss of woodlands to construct residential buildings to house an increasing population. In addition, the city's social and economic structure has changed from an agricultural to an industrial and then service industry based model. This has resulted in a reduction of agricultural land and deterioration of the *satoyama* coppices that once provided people with firewood and that were home to a diverse range of wildlife [(3)].

Development of the initiative

Key aims

Given the threats of climate change and the loss of green spaces in the city, Nagoya has undertaken various measures to create more sustainable urban lifestyles [(1)]. The key initiative that aims to increase green space in the city is the **Nagoya Strategy for Biodiversity** [(5)], which recognises the links between the green space cover and the urban heat island effect. The Nagoya Strategy for Biodiversity also includes **Nagoya Water Cycle Revitalisation Plan**, which aims to re-establish the natural water cycle, which has been disturbed due to continued urban development [(3)]. The implementation of these initiatives is likely to increase green cover in the city and help to moderate temperatures.

Themes driving the initiative

National legislation

- **Biodiversity:** In 2008, the Japanese government adopted the "Act on Biodiversity" which recommends that all Japanese local governments adopt a Local Biodiversity Strategy and Action Plan (LBSAP). These local strategies align with the National Biodiversity Strategy and Action Plan, which Japan developed as a signatory to the Convention on Biological Diversity.

- **Urban heat island**: In 2001, the urban heat island (UHI) was declared by the Ministry of Environment as a form of air pollution. In 2002, a cross-departmental 'Inter-Ministry Coordination Committee to Mitigate Urban Heat Islands' was established. In 2002, the Cabinet adopted the 'Basic Rules for Urban Renaissance', which included urban heat island mitigation as a means of revitalising urban areas. In 2004, the 'Outline of the Policy Framework to Reduce Urban Heat Island Effects [(6)] was established. This was accompanied by a set of guidelines which specified that building owners should plant trees and provide green spaces around their buildings as a UHI mitigation measure, and also provide green roofs and green walls where appropriate. At the city level, provision of green spaces and parks, as well as extensive green belts, is promoted as a key UHI mitigation measures. In 2005, the

Government designated several model areas for investigating measures for mitigating the UHI, including the Nagoya Station, Fushimi and Sakae districts [7].

A history of environmental initiatives in Nagoya

The City of Nagoya launched its first environmental conservation initiatives in the early 1950s to improve the water quality of the city's rivers and at the Port of Nagoya. Air pollution started to be monitored and controlled in 1960s. The Nagoya City Basic Concept, developed in 1977, emphasized the importance of a green environment in city planning. This was followed by the adoption of the "Greening City Declaration" in 1978. Growing public interest in the planting of greenery motivated the city to develop greening projects with public participation. In the 1990s, following the increased interest in sustainable development, the City of Nagoya enacted the Environmental Basic Ordinance to promote the emergence of a sustainable society capable of minimizing its environmental impact [5].

Emphasis on environment in the city development strategy

The City of Nagoya aims to become the Environmental Capital of Japan [4]. This aim is to be achieved by following three initiatives:

- A low-carbon society, with the 2050 target of 80% reduction in CO_2 emissions, which has been incorporated in the 2050 Nagoya strategy for Low-carbon city [2], [4]. This aims to concentrate development around train and subway stations freeing up land for green space elsewhere.
- A society that coexists with nature, guided by the Nagoya Strategy for Biodiversity, which emphasises actions such as the preservation and wise use of wetlands, the regeneration of Higashiyama Zoo and Botanical Gardens, and the creation of managed *satoyama* woodlands.
- A recycling-based society, guided by the Biomass Town Plan and the 2050 Nagoya Strategy for Water Cycle Recovery.

These initiatives aim to achieve the vision of **Low-carbon comfortable city Nagoya** (Figure 2).

Image of a „Low-Carbon and Livable City Nagoya" in 2050
© Landscape-Plus Co., Ltd.

Figure 2. Vision of Nagoya in the future [2]

Water management problems

Urbanisation processes have inhibited the functioning of the natural water cycle. For example, the volume of rainwater permeating into the ground has been decreasing due to surface sealing. Further, the increased surface runoff of rainwater has raised the load on sewage systems and rivers. Meanwhile, the volume of water within the evapotranspiration process has been declining, which in turn has exacerbated the heat island effect. In an effort to resolve these problems, the city developed the Nagoya Water Cycle Revitalization Plan in 2008 [5].

Participation in international networks and projects
Nagoya will host the 10th **Conference of the Parties to the Convention on Biological Diversity** (CBD COP10) in October 2010. Furthermore, Nagoya is a member of ICLEI – Local Governments for Sustainability - and has participated in ICLEI's Local Action for Biodiversity project as well as ICLEI's Cities for Climate Protection Campaign.

Details of the initiative

The Biodiversity Strategy clearly acknowledges the effect of green spaces in moderating the urban heat island. The target for the Strategy is to increase the green space cover in the city from the current 25% to the 1967 levels of 40% [(4)]. To achieve this target, the main objectives of the Strategy are as follows [(5)]:

- To conserve existing open green spaces, including private woodlands.
- To promote greening of roads. The area of new green spaces has been increasing steadily through tree planting, continuous greening with shrubs, and the greening of median strips.
- To improve the provision of greenways, i.e. roads where the pedestrian and cycle traffic have a priority and the vehicle traffic is restricted.
- To promote local greening. This program is intended to facilitate the cooperation of local residents, private enterprise, and government to develop greening agreements.

An important element of the Biodiversity Strategy in Nagoya is the **Water Cycle Revitalisation Plan**, which aims by 2050 to increase the infiltration of water into the ground from the present level of 24% to 33%, and to reduce runoff levels from 62% to 36%. This is to be achieved through protection and increased provision of green space, green roofs, permeable paving and structural measures [(4)], allowing the infiltration of rainwater to ensure the effective use of underground water and recycled sewage water [(3)] (Figure 3). The main objectives of the Plan are as follows [(5)]:

- To restore the functions of the natural water cycle by increasing infiltration of rainwater and facilitating the evapotranspiration process;
- To undertake city planning while factoring in a people-friendly waterfront and green environment that is also beneficial to wildlife;
- To revive the water cycle via partnerships based on mutual understanding of respective roles of stakeholders, and collaboration among the public, NGOs, private sector, and government.

Implementation of the initiative

The 2050 Nagoya Strategy for Biodiversity was developed in 2008 and runs until 2050. Street greening initiatives are carried out by the City of Nagoya (Figure 4) in close collaboration with local residents and businesses. Three interesting mechanisms are being used in the implementation of the Strategy and the Nagoya Water Cycle Revitalisation Plan:

1. Under the programme of preservation of existing green spaces, the City of Nagoya uses "loan for use" agreements with private green space landowners in order to secure favourable urban environments and provide the public with opportunities to experience local natural surroundings [(5)].
2. An incentive scheme for developers is applied, which allows developers to increase the volume of their buildings if they concentrate their development on a smaller land footprint and allow for creation of continuous green areas (for a similar example see the City of Faenza).
3. In order to reduce the heat island and enhance water infiltration, the City of Nagoya recently established a policy to require tree planting on all plots of new development over 300 m^2. Greenery must account for 10-20% of the plot. Compliance with the rule is now a precondition for planning permission [(8)].

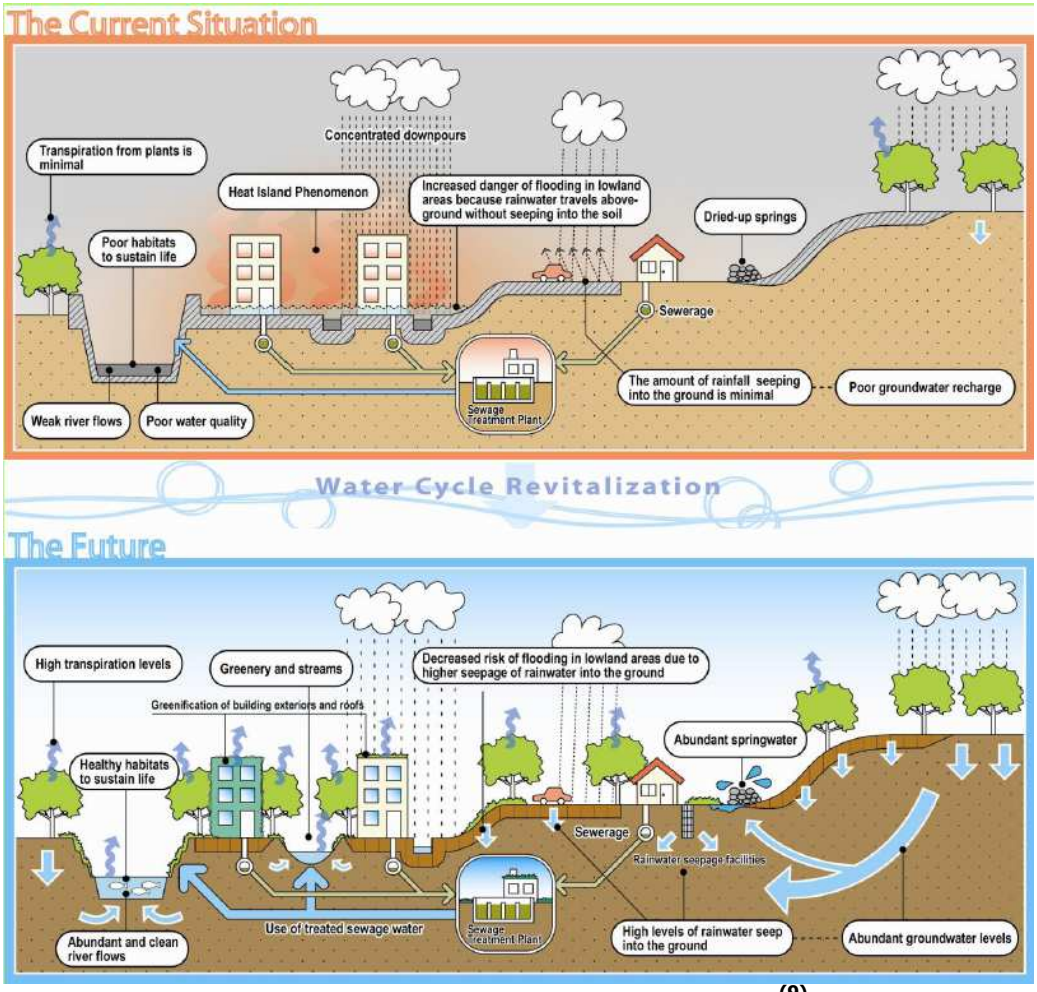

Figure 3. The Water Cycle Revitalisation Plan [(9)]

Challenges and barriers to implementation

A key challenge in promoting biodiversity conservation in Nagoya is that the term "biodiversity" is not well recognised. To address this, the City of Nagoya raised awareness that biodiversity conservation is a critical and shared challenge for members of the public, the government, and private sector [(5)].

Furthermore, while the awareness of climate change is high among the general public and the city officials, it is not explicitly linked to present day extreme weather events. In terms of climate change, emission reduction is the first priority. In terms of adaptation to climate change impacts, living with rising sea levels is seen as the key priority. While the urban heat island effect is well recognised and is seen as a problem that should be solved, it is not linked to public awareness of climate change. Indeed, the main effect of climate change is perceived as being flooding.

Another challenge is the relatively weak position of the Environmental Department in the preparation and implementation of policies. However, this has been addressed through close collaboration with the Department of Planning and Construction, who manage the road network, enabling greening of the streets to be carried out in a collaborative manner.

Figure 4. Central Park in Nagoya separating two lanes of traffic – an example of greening in the city centre of Nagoya. Photograph by Aleksandra Kazmierczak

Building the evidence base

The Greenification & Public Works Bureau conducts surveys on the ratio and trends of green space in the city. This facilitates the preparation of basic materials for raising public awareness, increasing the ratio of open green space, and developing measures for mitigating the heat island. Compiled from aerial photography and data from the Geographical Information Service (GIS), this survey has been conducted every five years since 1990 [(5)]. Also, there are a number of research projects being carried out at the University of Nagoya. These are investigating the possibility of achieving the vision of low-carbon, comfortable city of Nagoya with different modes of urban planning and methods of greening that would limit the severity of urban heat island.

Monitoring and evaluation

The Strategy for Biodiversity includes clear targets for the percentage of green space that should be greened and the proportion of water that should infiltrate into ground in the future. These targets enable monitoring of the progress in achieving the aims of the Strategy.

Stakeholder engagement

While the City of Nagoya is the lead authority on the Biodiversity Strategy and the Water Cycle Revitalisation Plan, the involvement of local residents and other stakeholders is emphasised. The policies aiming to reach the 2010 biodiversity target focus on three key themes; sustainable lifestyles (e.g. Nagoya Water Recovery Plan), human resource development (e.g. environmental education) and co-existence with nature (e.g. preservation and creation of green areas, forestation). All three themes place emphasis on public participation. In particular the collaboration between an Experts Board a Citizen Review Board in the Nagoya's Biodiversity Strategy Committee is interesting (Figure 5). Also, as part of efforts to promote and elevate awareness of biodiversity conservation, the city is working to improve the water quality of rivers by introducing groundwater as well as by monitoring and surveying spring water (which is to be monitored by members of the public) [(5)].

In addition, many public open green spaces are managed and administered through collaboration between the City of Nagoya and citizens' groups [(5)]. In the *Higashiyama* Forest, citizens' groups are working together on various projects, such as maintaining woodlands and holding nature watch tours. In the south-west of the city, where little existing woodland remains, the *Todagawa* Green is being developed. This unique public-private project, named 'Building the Western Woods of Nagoya', is being carried out in partnership between citizens, corporations and government for planting and cultivating trees to create a forest for future generations [(3)]. COP10 promotes the idea of *satoyama* and supports the activities of citizens in planting and maintaining woodlands. A specific example is the Nagoya partnership for improving forests (Box 1).

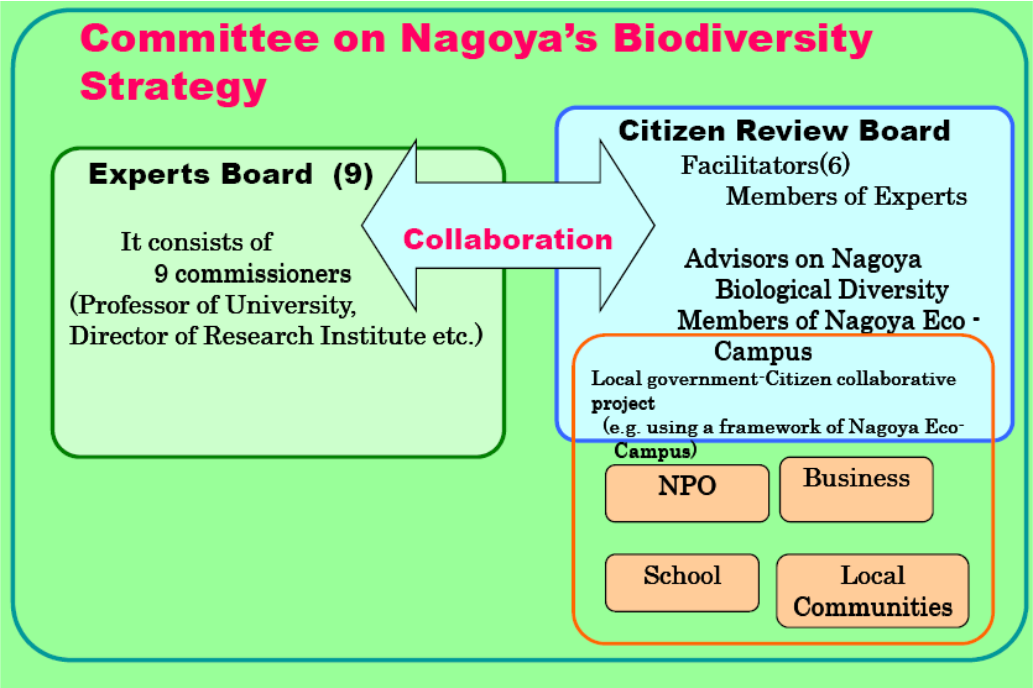

Figure 5. Emphasis on collaboration between experts and citizens on the Biodiversity strategy [10]

Box 1. Nagoya Partnership and Liason Meeting for Improving Forests [5]

In March 2003, the Nagoya Partnership and Liaison Meeting for Improving Forests was established via cooperation between the City of Nagoya and citizens' groups working on the conservation and redevelopment of the natural environment and parks and green spaces in the city. The Liaison Meeting promotes activities working toward the common objective of protecting and fostering local natural features whilst respecting the autonomy of citizens' groups and the public duties of the government. As of September 2007, 28 organizations had participated in the Liaison Meeting.

The liaison meeting facilitates information exchange amongst organizations through regular meetings, field visits and workshops. In addition, partnership projects are developed with relevant government organization in an effort to share challenges, add momentum to activities, and expand the network of cooperation.

In 2009, a conference on biodiversity management for local authorities in Nagoya was attended by 200 participants, with more than 100 representatives from Japanese local governments. The event offered an opportunity for delegates to share information and learn from each other in view of preparing their local planning documents and improving biodiversity management and conservation at a local level.

Political buy-in

Political engagement was necessary to secure the necessary level of support for and momentum behind the CO_2 and biodiversity initiatives that Nagoya is now involved in. The City mayor, Takehisa Matsubara, has been proactive in this respect.

Can it have an impact?

The increased greening of the City of Nagoya can be seen as an achievable goal because it lies at the core of strategies targeted at biodiversity conservation, water cycle improvement and achievement of a low-carbon, public-transport based economy. This multi-functional cross-sectoral

approach increases the possibility of greater provision of green space in the city. Furthermore, the collaborative approach of the city (both inter-departmental as well as collaboration with citizens and local businesses) makes it more likely that the city will be greened, and therefore better adapted to the urban heat island effect and flash flooding in the future.

The linking of climate change mitigation and adaptations strategies into one vision for the future of the city can be considered as a very effective way of raising the profile of adaptation. However, the danger remains that the push for mitigation will overshadow the need for adaptation, and that adaptation will be seen as an 'add-on' to the overall climate change and biodiversity policy.

Key messages

- The biodiversity and water infiltration targets are to be achieved through close cooperation with citizens. The City of Nagoya has recognised that only by working with residents and local businesses will it be possible to achieve the vision of low carbon, liveable city. The Japanese culture emphasises the need for individuals to contribute to the common good, which supports public involvement in such initiatives.

- The involvement of the City of Nagoya in international initiatives, such as ICLEI and the organisation of the COP10 conference, has raised the profile of environmental issues locally and helped to provide political buy-in for related actions.

- The vision of the city's future development takes an integrated approach linking adaptation and mitigation. It emphasises the importance of controlling urban sprawl and concentrating the built environment around transport hubs, while at the same time increasing the presence of green areas to improve biodiversity, water management and help to reduce the urban heat island effect.

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4 Lessons learnt from the case studies

A range of lessons have been extracted from the 15 case studies described in this report. These have been organised according to issues relating to climate change adaptation planning and decision making. The issues covered relate to the process of adaptation planning and decision making, for example collaborative working and developing a sound evidence base, rather than guidance for adaptation actions such as green roof techniques. As the lessons are generic, they are broadly transferable across sectors and spatial scales. The lessons are accompanied by practical 'tips' that suggest ways in which organisations can incorporate these issues into climate change adaptation planning and decision making.

Lessons relate to the following issues:

- Triggers for action, or the reasons why an action is considered by the organisation.
- Continuing leadership and championship.
- Raising awareness within the organisation, amongst stakeholders and with the wider public.
- Collaborative working; how internal and external collaboration, and in particular cooperation with research institutes, has facilitated a stronger adaptation response.
- Learning from others, in terms of adaptation processes and/or adaptation actions.
- Developing a sound evidence base, either using in-house expertise or by outsourcing experts.
- Public engagement on adaptation issues.
- Embedding adaptation in decision making through policies, plans, regulations or incentives, and via close collaboration with developers.
- Funding for adaptation responses.
- Monitoring and evaluation of adaptation responses.

The lessons can be linked to different stages of the adaptation planning cycle being utilised by GRaBS partners (Figure 1). This cycle relates to a generic set of planning stages which are relevant to any organisation engaged in climate change adaptation planning and decision making. The majority of the lessons learnt from the case study database relate to the early stages of the adaptation planning cycle. Collaborative work and public engagement are best applied throughout the process of development of climate change adaptations strategies.

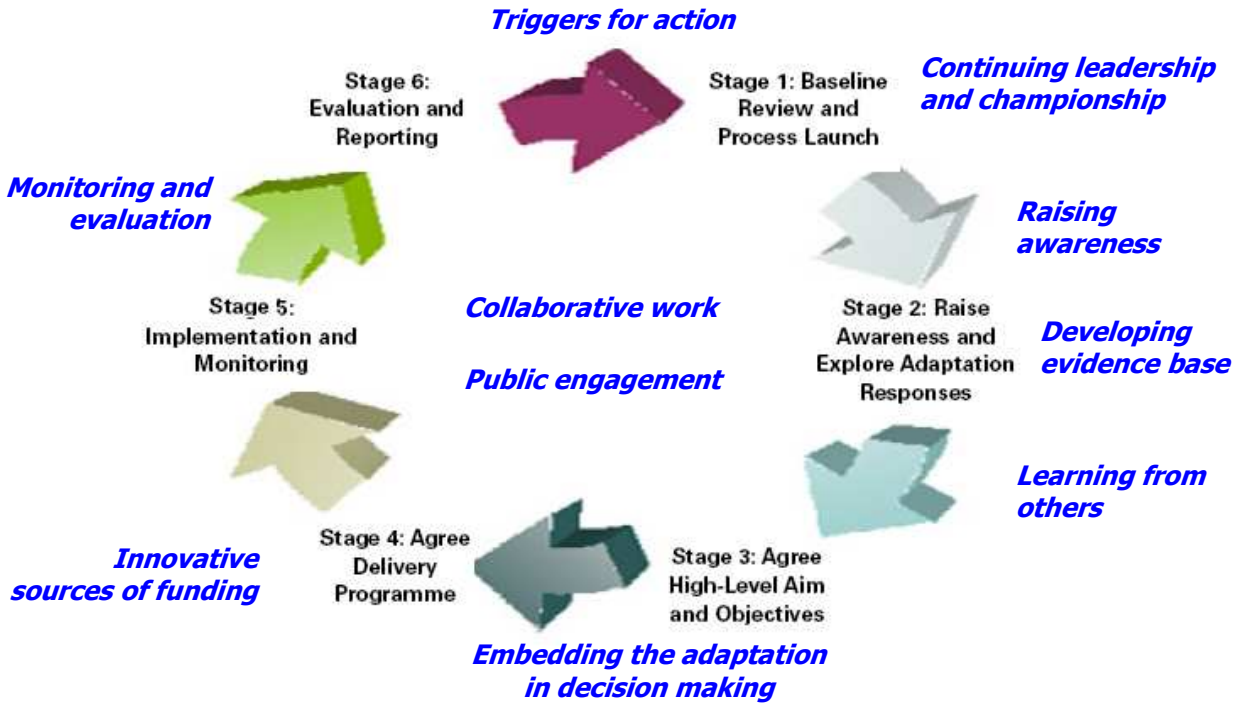

Figure 1. Links between the Adaptation Action Planning Cycle and the lessons learnt from case studies

4.1 Triggers for action

Increasing the profile on adaptation the policy agenda will ultimately be necessary in order to progress the implementation of adaptation responses based on green and blue spaces. The importance of adaptation to climate change impacts is often seen as a lower priority for decision makers than the need to mitigate climate change through reducing levels of CO_2 emissions. Increasing the profile of adaptation makes it more likely that it will be incorporated into the decision-making process. More often than not, an impulse is needed for adaptation to be included on the policy and plan making agenda. Six of these 'triggers for action' have been identified within the case studies.

4.1.1 Presence of legislative or policy frameworks at higher levels

Several case studies emphasised the importance of policy and legislative frameworks at higher levels, which set a framework for adaptation responses within local authorities or other organisations to build upon. The impact of high level policy is visible in the case studies from the UK: London Borough of Sutton and North West England. In the latter case, the emergence of the regional climate change action plan was accelerated by the Climate Change Act, which requires action to be taken on both climate change adaptation and mitigation, and statutory regional strategies highlighting the importance of capturing potential benefits of green infrastructure in adaptation to climate change. The London Borough of Sutton case shows that a policy framework requiring measures mitigating the impact of floods and promoting green and blue spaces can successfully guide local authority adaptive actions. Further, Japanese national policy on the development of city level strategies on biodiversity and urban heat islands, which emphasise the use of vegetation, stimulated development of the Nagoya Biodiversity Strategy. In Seattle, State of Washington regulations requiring local authorities to implement policies reducing losses caused by natural disasters motivated the city to develop regulations on maintenance of vegetation in areas prone to landslides. In the case of Dorset, national regulations on biodiversity conservation, which implement EU Directives, supported the use of financial contributions from developers for heathland preservation activities.

Tip: Scan national and regional policies and strategies looking for references to adaptation to climate change and its impacts (e.g. flooding, high temperatures, fires), and references to green and blue spaces (e.g. biodiversity or recreation). Relating adaptation action plans to high level policies can give them a stronger mandate, improving buy-in amongst decision makers and potentially accelerating implementation activities.

4.1.2 Current problems associated with weather and climate

The presence in a particular area of frequent weather-related disasters and extreme events that cause significant losses (for example floods, wild fires, hurricanes, landslides, or heat waves) can trigger actions that build capacity to adapt to climate change. The case studies demonstrate that in a number of locations, green and blue infrastructure actions have already been taken or are currently underway to respond to weather related events that will aid long term adaptation to future climate change. This is significant as in many locations, climate change is likely to exacerbate and intensify current patterns and extremes of weather and climate.

The most extreme case reported in this database is New Orleans. The disastrous effects of Hurricane Katrina showed how mal-adapted the city was, and highlighted that protection from flooding caused by hurricanes cannot be limited to the use of structural defences with coastal restoration also now vital. In Seattle, the landslides of 1996-97 made problems associated with

ground instability following intense rainfall very apparent and led to changes in planning regulations to protect and enhance the role of vegetation in stabilising slopes. In the case of the London Borough of Sutton, floods in 2007 caused a greater consideration of the need to utilise spatial planning to adapt to future flooding. In Chicago, weather events associated with significant loss of life and property damage - flash flooding in 1996 and a heat wave in 1995 - triggered actions associated with adaptation to such events. In Dorset, heathland fires associated with encroaching development motivated local authorities in the area to act to reduce this threat.

Tip: Carrying out a review of weather-related incidents that have caused life or property-loss in an area can help to identify those weather events that need the most urgent action locally. Being prepared for a reoccurrence of events that have happened in the past may help to prepare for similar events in the future, even if decisions made and actions undertaken are not explicitly associated with adaptation to long term climate change.

See the UK Climate Impacts Programme advice on how to carry out a Local Climate Impact Profile:
http://www.ukcip.org.uk/index.php?option=com_content&task=view&id=278&Itemid=377)

4.1.3 Multifunctionality of green and blue infrastructure: delivering wider benefits

The achievement of other sustainability benefits associated with the use of green and blue infrastructure (e.g. climate change mitigation, biodiversity conservation) often seems to be a more significant trigger for action than the climate change adaptation agenda itself. This multifunctionality distinguishes adaptation to climate change with the use of green and blue infrastructure from other types of adaptation responses, such as structural changes to buildings or flood barriers. Achievement of other sustainability benefits means that green and blue infrastructure can often be regarded as a 'no-regrets' option, which can increase the support for such adaptation responses amongst local authorities and elected officials.

The North West of England, Nagoya and Toronto have increased focus on adaptation by linking it explicitly to the mitigation agenda as a necessary consideration associated with climate change. Also, in Chicago, the promotion of green roofs was mainly associated with the climate change mitigation agenda, following the identified fall in building energy use caused by the green roof on Chicago City Hall. Similarly, in Basel, green roofs were initially focused on energy-saving. Subsequently, based on research into the role of green roofs as valuable habitat, the focus shifted to encompass biodiversity conservation.

The role of green spaces in preserving biodiversity and encouraging wildlife in cities was an important impulse for action for several local authorities described in the case studies. In Nagoya, although the adaptive role of green spaces is included within the Biodiversity Strategy, the improvement of habitats is the main driver for enhancing green cover in the city. Further, the case study of Berlin shows that undertaking actions aimed at supporting biodiversity in densely built-up urban areas (using the Biotope Area Factor), can also generate adaptation functions.

In Faenza, the creation of green spaces not only provides cooling benefits, but also improves the quality of life in the town. In the Slovakia case study, the development of standards aimed at the better provision of green spaces in towns and cities was motivated by improving of quality of life, preservation of biodiversity, and climate change adaptation. The contribution of green infrastructure to the economy of North West of England was an important driver behind its consideration in regional policies.

Tip: If the contribution of green and blue infrastructure can be aligned to the delivery of strategic priorities for an area, for example biodiversity conservation, improvement of quality of life, or mitigation of climate change, this will strengthen its position on the policy agenda. If green and blue infrastructure responses are taken forward as a result, this will in turn have benefits for climate change adaptation in the area.

4.1.4 Capitalising on previous and existing environmental initiatives

Strong environmental or ecological traditions in a given country may provide a platform for the development of adaptation initiatives based on green and blue infrastructure. This is apparent in case studies located in Germany (Berlin and Stuttgart) and Switzerland (Basel). Similarly, the previous involvement of local or regional authorities in environmental or sustainability initiatives can provide a useful springboard for the development of adaptation actions. For example, in Nagoya, there is history of environmental and green space initiatives dating back to the 1970s. In Faenza, Local Agenda 21 enhanced the involvement of developers and citizens in sustainability issues in the 1990s. In Dorset, the existing Urban Heath Partnership assisted the establishment of the heathland wild fire reduction initiative. In Sutton, the "One Planet Living" project provided an impetus for a focus on adaptation issues in the Borough's spatial planning strategy. In Toronto, a number of existing initiatives relating to green and blue spaces worked to reinforce their importance in the adaptation strategy. Specifically with relation to action on climate, Toronto capitalised on an existing climate change mitigation plan, whilst the North West of England built on green infrastructure expertise in the region developed through previous research projects.

Tip: Capitalising on previous/ongoing environmental and sustainability-oriented initiatives can support the process of developing green and blue infrastructure adaptation responses. The initiatives that are particularly useful are those focused on climate change mitigation, recreation and biodiversity. Utilising established networks and partnerships can provide a springboard for a collaborative approach to adaptation and public engagement.

4.1.5 Need for development despite climatic impacts

While environmental concerns and economic growth are sometimes seen as conflicting issues, the case studies demonstrate examples of where the inclusion of green and blue space adaptation responses measures is possible in conjunction with intensive urban development and expansion. The London Borough of Sutton has shown that a strong planning policy framework, which simultaneously supports housing growth and the minimisation of flood risk from new development, can lead to the creation of innovative development plans. In Seattle, the identification of areas prone to landslides alongside passing regulations on the maintenance of vegetation in these areas helps to ensure that development is carried out in a safe manner in these locations. In the Netherlands, a public awareness raising campaign has emphasised the need to "make room for water" in order to secure future development prospects for the country. In Chicago, densification of development in the intensely built-up city centre has been accompanied by the promotion of flood risk and heat island countermeasures, including those utilising green roofs.

Tip: Case studies in this database (and other sources in Appendix 1) can be used to identify methods of incorporating green and blue spaces into development in a manner that does not constrain the economic growth and urbanisation of an area. It is also important to emphasise benefits stemming from the inclusion of green and blue infrastructure in developments (e.g. energy saving, higher rents, higher property prices, etc).

4.1.6 Improving competitiveness through environmental improvements

Urban green spaces can significantly enhance the image of a city. This is particularly true for cities and regions where their history has been associated with heavy industry, or in areas in need of urban regeneration. In Malmö, the Augustenborg neighbourhood shows that inclusion of green and blue spaces for adaptation purposes (in this case flood risk management) can stimulate socio-economic regeneration. Chicago and Nagoya strive towards the recognition as, respectively, "the greenest city in America" and "the environmental capital of Japan." An important element of achieving these lofty goals is the promotion of green spaces to aid climate change adaptation and mitigation, improve biodiversity and increase quality of life. In the North West of England, green infrastructure has been recognised as an asset bringing many tangible monetary benefits and, consequently, contributing to the economic growth of the area.

Tip: Green and blue infrastructure can be promoted as an important asset, which has the potential to improve an area's image and may ultimately raise the competitiveness of an area. This could bring economic benefits including increased inward investment, which may in turn stimulate further expansion of green and blue infrastructure. .

4.2 Continuing leadership and championship

In the majority of the 15 case studies described within this database, climate change adaptation was not a priority issue prior to undertaking action, and in some cases remains a 'hidden benefit' linked to the achievement of the key goals of an action. In many cases, establishing adaptation and/or green and blue infrastructure on the decision-making agenda was a result of the enthusiasm and commitment of one individual, one organisation or a particular stakeholder partnership. Moreover, securing a leadership role was often key to the success of an initiative. The Mayor of Chicago provides an example of where the 'champion' was also a city leader, who ensured that green and blue infrastructure was a priority issue in policies and regulations developed by the city council. However, adaptation can also be championed by individuals with less political power. In Malmö, a small collection of individuals including an officer from the Service Department, a housing manager, and a co-ordinator for the Urban Programme in Malmö managed to convince senior city officers to begin the regeneration of Augustenborg and to focus this on green and blue spaces. In Basel, a university researcher acted as a leader of the green roof agenda, resulting in the incorporation of biodiversity-related specifications in green roof regulations for the city. The North West of England and Slovakia case studies provide examples of successful adaptation initiatives championed by non-governmental organisations.

Tip: Often one department / agency / organisation within a city or region will be been active in the field of adaptation to climate change and/or the promotion of green and blue infrastructure. Sometimes one committed individual may be leading the adaptation agenda. Close collaboration with this unit / organisation / person, including strengthening their status through internal mechanisms or official subcontracting, can enhance the development of green and blue infrastructure adaptation responses.

4.3 Awareness raising

The need for adaptation measures is generally less well recognised and understood than climate change mitigation responses. Therefore, there is a need for awareness raising and knowledge sharing actions within organisations preparing adaptation responses, amongst stakeholder groups and with the wider public. There is also a need to increase awareness of the adaptation functions of green and blue infrastructure, as these are often secondary to the achievement of the key goals of related initiatives explored within this case study database. The case studies have highlighted examples of successful awareness raising approaches both within organisations developing adaptation responses, with external stakeholders and with the public. These can enhance the implementation of adaptation responses.

4.3.1 Within the organisation

In Toronto, a wide range of actions were undertaken in order to increase awareness of the City Council's employees about the need for adaptation to climate change impacts. These involved attendance at workshops and conferences, participation in online seminars, and learning from examples of approaches from other cities. In North West England, a research project funded by the Regional Development Agency helped to raise awareness within their organisation of the economic benefits of green infrastructure. This research helped to strengthen its position on the regional policy agenda. In Chicago, any solutions recommended to developers or required for them to obtain planning permission, are initially being tested by City Council staff or applied to public buildings and land in order to ensure the feasibility of the solutions. This also results in higher awareness and knowledge of adaptation and green infrastructure issues within Chicago City Council.

Tip: Providing awareness-raising activities for staff on adaptation issues, bringing in external assistance where required, can benefit the development of adaptation responses. Involving research institutes or non-governmental organisations with an interest in adaptation and/or green infrastructure will help to secure good quality of information for decision making. This database and others like it can raise awareness of a range of possible solutions that could be used in building adaptive capacity or developing adaptation responses in organisations pursuing this agenda.

4.3.2 Among the stakeholders and wider public

"The Netherlands Live with Water" campaign, which involves various communications media, provides an example of a comprehensive approach to raising of public awareness at the national level. At the city scale, the Live Green Toronto website was established to increase awareness of the need for adaptation among the city's residents. Similarly, in Chicago, the Center for Green Technology offers tours, workshops and other opportunities for people to learn about green buildings. The City of Chicago also provides best practice management guides for developers, focusing on issues such as stormwater management and green roofs. Seattle provides an extensive outreach programme, which includes public meetings as well as a number of client assistance memos, which describe the regulations relating to protecting and enhancing vegetation in areas threatened by landslides in an easy to understand manner. Communications exercises such as these have the potential to increase the effectiveness of both the development and implementation of adaptation responses.

Tip: The use a variety of approaches to raise awareness of adaptation issues amongst the public, including simple and engaging advertisements on TV and radio and in newspapers, are a good way to communicate a message to a wide range of people. It the target audience is smaller, meetings and study tours are a good way to familiarise people with the adaptation agenda. When working with developers, provide them with as much information as possible in a suitable format can enhance collaborative relationships.

4.4 Importance of collaborative working

Collaborative working is an important element of the development of climate change adaptation strategies and plans. Collaboration is necessary internally between different departments, and externally with relevant stakeholder groups. The case study database has uncovered good examples of both, as discussed below.

4.4.1 Internal collaboration

Climate change adaptation is a complex issue which impacts across the different departments of local and regional authorities. Therefore, cross-departmental working is crucial for the effective development and implementation of comprehensive and achievable adaptation strategies and plans. Examples of cross-departmental working include the City of Toronto, where an inter-division Adaptation Steering Group was established to prepare the climate change adaptations strategy for the city. In the London Borough of Sutton, a Flood Group was formed including representatives of different departments affected by flooding, and also external stakeholders (see 4.4.2 below). In Seattle, an Interdepartmental Landslide Team was established to lead on the development of new policies and to manage a public outreach programme. The establishment of cross-departmental formal teams working on particular climate change related problems has proved effective in these cases. However, smaller scale interdepartmental cooperation can also bring significant benefits. Close collaboration between city departments responsible for environmental issues and spatial planning helped to secure successful implementation of the Biotope Area factor in Berlin, the Biodiversity Strategy in Nagoya and the planning recommendations of the Climate Atlas in Stuttgart.

Tip: Identification of the departments/divisions within the organisation which have a stake in climate change adaptation (i.e. are affected by climate change impact or can help to implement adaptation responses) or in green and blue infrastructure issues can then lead to the development of an adaptation network. The ideal size of these groups will depend on the climate change impact(s) being addressed and the nature of the adaptation response being developed. Developing a list of tasks and a schedule of meetings can help to formalise the process. Given the importance of land use issues for the development and implementation of green and blue infrastructure adaptation responses, ensuring that the department responsible for spatial planning and development control is represented in the group is vital.

4.4.2 External collaboration

Several of the case studies include examples of the creation of stakeholder networks to drive forward the development and implementation of climate change adaptation responses. At the local level, the development of a spatial planning strategy for Sutton was carried out by a Local Strategic Partnership, which brings together relevant stakeholders from the area under the leadership of the Borough Council (this is a statutory requirement under spatial planning legislation). Furthermore, in Sutton, external stakeholders were invited to join a Flood Group, which contributed to development of specific planning policies on flooding. In North West England, the regional Climate Change Action Plan is being implemented by a partnership of 18 bodies, each of whom are responsible for implementing one or more of the actions in the plan. In Dorset, a partnership including national agencies and non-governmental organisations, but predominantly made up of local authorities within the South East Dorset, designed a policy document on protection of heathlands. Smaller external collaborations were developed in Basel and Malmö, where adaptation responses were achieved thanks to collaborations between local authorities and a research institute (Basel) and a housing association (Malmö). Examples of partnership where vertical links were developed between local, regional and national authorities can be seen in the cases of Seattle (landslides) and New Orleans (flood protection). Collaboration between different levels of government ensures that adaptation initiatives benefits from competencies at various spatial scales, e.g. national legislation, regional policies, and local land use regulations.

Tip: Utilising existing networks and partnerships should be encouraged. It is also important to identify organisations and agencies with a stake in climate change adaptation and green and blue spaces. Investigating possibilities of collaboration with national or regional agencies, or with neighbouring authorities, can also strengthen adaptation responses. Involving non-governmental organisations, recognised experts and research institutes is a constructive way of drawing on a wider range of knowledge and experience. A partnership model with a clear role for engaged stakeholders should ideally be established.

4.5 Learning from others

The application of good practice from other cities is common amongst the 15 case studies explored. The strategy of coastal flood risk management in New Orleans, which utilises different lines of defence including wetlands, is based on Dutch principles of 'making room for water' rather than relying on structural flood defences. In Berlin, the digital environment atlas for the city, which has a particular focus on local meteorological conditions, was developed following the example of Stuttgart's Climate Atlas. In turn, the development of open space standards in Slovakia was based on Berlin's Biotope Area Factor, as well as other green space provision models developed in Austria, the UK and Sweden. Planners in Sutton have drawn on existing good practice guides, such as the 'Climate Change Adaptation by Design' handbook produced by the UK Town and Country Planning Association (see Appendix 2).

The case studies also reveal that organisations are actively sharing their good practice with others. For example, a multi-lingual website has been set up for the Biotope Area Factor in Berlin allowing others to access information about the initiative. Similarly, a website for the Augustenborg neighbourhood in Malmö was set up, which describes the processes and technical aspects of retrofitting SUDS into a deprived urban area in detail. The Chicago approach to greening the city and the development of sustainable buildings is widely publicised by the Center for Green Technology. Indeed, the model of Chicago's Green Permit Program has been followed by numerous municipalities in US. The Town Planning Regulations in Faenza which are based on negotiating building quotas with developers have received wide recognition, and have gathered a number of national, European and international awards. Faenza's approach is now being followed by other municipalities in the region, for example Mirandola (see Appendix 1).

One of the most effective ways to learn from others is by participating in networks of cities and 'research-to-practice' projects focusing on green infrastructure and adaptation issues. For example, Nagoya is a member of ICLEI – Local Governments for Sustainability - and has participated in ICLEI's Local Action for Biodiversity project as well as ICLEI's Cities for Climate Protection Campaign. Hosting the Conference of the Parties to the Convention on Biological Diversity in October 2010 has provided an additional driver for Nagoya to produce and implement its biodiversity strategy. Toronto joined the Alliance for Resilient Cities network of Canadian cities, and the U.S. Urban Leaders Adaptation Initiative, to exchange information and ideas with peers in other cities. The city also established the Toronto Urban Climate Change Network to support co-operation among governments, universities, colleges and non-governmental organizations on climate change mitigation and adaptation actions and strategies relevant to the City of Toronto.

In Dorset, participation of the Urban Heath Partnership in a European Union LIFE-Nature project laid the foundations for the development of wild fire mitigation actions funded by contributions from developers. London Borough of Sutton benefited from participation in a LiFE project (Long-term Initiatives for Flood-risk Environments), which led to the creation of a masterplan for the Hackbridge neighbourhood which identified a wide range of flood risk mitigation and other climate change adaptation measures. The subsequent participation of Sutton in the GRaBS project has ensured a firm focus on green and blue spaces in the development of adaptation responses to climate change impacts, and the project has also provided the Borough with a bespoke tool for the assessment of local vulnerability to climate change hazards.

Tip: This database, and the other sources listed in Appendices 1 and 2, offer insights into adaptation practice for organisations to draw on. Organisations should be encouraged to tell others about innovative adaptation approaches they have developed by including information on their organisation's website.

Joining existing networks of cities, or relevant organisations locally, nationally or internationally, can support adaptation activities. If there are no networks locally, establishing one could be possible. Becoming partners in projects which focus on exchange of experiences, and participating in seminars, conferences and study tours offered, can also be beneficial. Similarly, taking part in programmes that involve research institutes can provide cutting edge knowledge and help to develop an evidence base needed to implement adaptation actions (see below).

4.6 Developing a sound evidence base

A good science and knowledge base is a prerequisite for designing and implementing effective adaptation responses. This relates to both the spatial targeting of adaptation responses through considering locations at risk of climate change impacts (which can inform the development of spatial plans) and the nature of the actual adaptation actions themselves (which supports the development of design guidance documents for example). The evidence base can be developed utilising in-house expertise, or by outsourcing the task to research institutes, consultancies and other organisations. Examples of both these approaches were identified within the case studies.

4.6.1 In-house expertise

Several of the case studies provide examples of where the evidence base needed to take forward adaptation initiatives was developed either partly or entirely within the organisation implementing the adaptation response. This was often made possible where there had been a long history of recording weather events causing problems in the locality. For example, Seattle had a database of landslides going back to 1960s, which informed the development of a comprehensive landslide inventory for the area. In Stuttgart, the city council has employed a meteorologist since 1938. This

has generated extensive data sets about local climatic conditions. Stuttgart also has a special Section of Urban Climatology within the Office for Environmental Protection. This knowledge and experience allowed the city's Climate Atlas to be developed. Berlin followed the example of Stuttgart, and their comprehensive digital Environmental Atlas was developed mainly using skills and resources from within the city's departments. In Toronto, the Environment Office was tasked with completing a study of recent climate trends and future climate projections for the region to help establish specific adaptation targets for different programmes produced by the divisions of the City of Toronto.

Tip: Reviewing the existing evidence base held within an organisation on weather and climate change and related impacts, and also the available skills base (is there a meteorologist, green space management specialist, or sustainability officer who could compile or collect data?) is important to establish whether additional data is needed and if there is the in-house capacity to gather it. These insights can be used to determine whether employing an external climate change expert is necessary in order to gather data on climate impacts that are the most critical for the area. It may be worthwhile considering setting up a small in-house team to work on climate issues in order to develop capacity within the organisation.

4.6.2 Outsourcing research

Cities and other organisations often benefit from outsourcing data collection and analysis associated with climate change and its impacts, even if their internal expertise is excellent. In Seattle, a comprehensive evidence base on climate, geology and landslide risk developed by the city was complemented by research carried out by the US Geological Survey and a consulting company. Their input enabled the city to identify areas where landslides are most likely to occur, and to develop special regulations on vegetation management to be applied in these areas.

In North West England, the importance of green infrastructure in adaptation to climate change was emphasised by previous research undertaken by the University of Manchester. In addition, research into the economic value of green infrastructure in climate change adaptation, and the geographical distribution of areas where the adaptive characteristics of green and blue spaces are the most needed, was carried out by Community Forests North West. In Basel, research at the Zurich University of Applied Sciences Wädenswil into green roof characteristics that maximise biodiversity played a key role in setting green roof design specifications and amending building regulations. The London Borough of Sutton employed consultants to conduct a local climate impact profile exercise and to undertake a surface water management study for their area.

Tip: Identifying and linking to local research institutes and non-governmental organisations with research expertise in climate change science, climate impacts and green infrastructure can bring mutual benefits. Such collaborations help to raise the profile of research outputs, and provide organisations responsible for implementing adaptation responses with good quality information to work with. Consultancy companies can also provide this function.

4.7 Engaging the public

Adaptation responses should ideally focus on the needs of people and communities, as it is often maintaining and enhancing quality of life and liveability of cities and urban areas that the initiatives are targeted towards. Further, the successful implementation of adaptation actions will sometimes require public support, for example to protect and maintain green spaces. The majority of the 15

case studies included elements public engagement, ranging from informing citizens about climate change impacts and the need to act, providing incentives for city residents to implement climate change adaptation actions, and actively engaging residents in decision making.

In many cases, public consultation is a statutory requirement during the development of local and regional planning policies (including London Borough of Sutton, North West of England, Dorset, Berlin, Toronto and Seattle), and it is therefore carried out according to legislative requirements. However, in some organisations public engagement in adaptation responses proceeded despite statutory requirements. The Netherlands case study illustrates a large-scale adaptive capacity building exercise based on engaging the Dutch people in climate change issues through the use of various media. In Seattle, informing citizens about the risk of landslides and the mitigating actions they could take was done through meetings, disseminating brochures and open public access to an evidence base on landslides. Initiatives in Stuttgart and Basel aimed to involve the general public through the provision of grants (Stuttgart) and incentives (Basel) for green roofs built by residents. In Basel, a competition for the best looking green roof proved very successful, and in Stuttgart there was a lot of interest generated in an 'adopt a tree' initiative.

In the Augustenborg neighbourhood of Malmö, a key objective was to enable residents to play a significant role in planning adaptation responses. Constant communication and in-depth community involvement enabled residents' concerns and preferences regarding the design of the stormwater system to be accommodated. This resulted in an additional benefit of local community empowerment around a wider set of issues. The development and implementation of the Biodiversity Strategy in Nagoya involved local residents to a great extent, by offering them the opportunity to collaborate with experts in the development of the Strategy, and involving residents in the management of many public green spaces. In Toronto, capacity building in the community is one of the main action streams in the adaptation strategy. This focuses on the development and implementation of a public and stakeholder engagement strategy, which involves creating a website outlining climate change impacts and adaptation responses, organising public meetings to discuss adaptation strategies as they develop, and supporting community and neighbourhood groups taking adaptation actions.

> **Tip:** Engaging residents in the development and implementation of adaptation responses from the start of the process will reduce the probability of people objecting to issues such as increasing green space at the expense of new development. Providing information via the media (TV, radio, newspapers) and webpages dedicated to adaptation and green infrastructure can aid adaptation responses. Public engagement going beyond information provision, i.e. consultation, participation in decision making, incentive schemes and collaborative administration, can further enhance the potential success of adaptation initiatives.

4.8 Embedding climate change adaptation actions in decision-making

Initiatives aimed at adapting urban areas to climate change impacts can take the form of guidance documents, new or revised policies, dedicated adaptation action plans, new or revised building codes, or the implementation of changes in land management practices or physical infrastructure. Non-governmental organisations, who have little decision-making power, are often limited to providing guidance on adaptation (the case of Slovakia). An example of physical landscape change is described in the Malmö cases study, where SUDS were retrofitted into one neighbourhood, and more examples of similar adaptation actions can be found in Appendices 1 and 2. There are several key means through which adaptation initiatives and actions such as these can be embedded in planning and decision making. These are described below.

4.8.1 Policies and strategies

High level policies tend to have a significant impact on spatial planning and land management activities in an area. In Nagoya, the Biodiversity Strategy is an overarching policy influencing future land use and development across the city, and includes strategies aimed at the improvement of water resources and reduction of urban heat island. London Borough of Sutton offers an example of where adaptation was weaved into policies directly affecting development activities on specific sites within local flood risk areas, although these were in turn supported by higher level planning policies.

> **Tip:** Developing high level policy statements referring to climate change adaptation with the use of green and blue infrastructure can set a context for local scale action. If the policy framework does not provide this, adaptation can be integrated within other strategies related to environmental improvements, e.g. biodiversity strategies. Inclusion of adaptation into specific site development policies can also aid action 'on the ground.'

4.8.2 Clear action plans

The case studies provide several examples of organisations going beyond policy development to the creation of specific adaptation action plans, which detail steps that need to be taken to build adaptive capacity and implement appropriate adaptation responses. Such action plans, which assign clear responsibilities for different partners or city divisions to deliver actions by specified completion dates, have been written by the cities of New Orleans and Toronto, and by the regional North West Climate Change Partnership in England.

> **Tip:** Once baseline information has been gathered and broad objectives discussed, an adaptation action plan with clearly assigned responsibilities for all participating parties, including city departments and/or stakeholders in a wider partnership, can be developed. Realistic time frames for the completion of actions should ideally be set. All interested parties should be involved in the development of the action plan.

4.8.3 Local regulations

In some countries, adaptation-related regulations at the city or regional level have been developed. Such regulations offer locally specific, legally binding requirements that will guide future developments and changes in land use. In some cases, regulations may also encompass the existing built environment. Examples of where regulations have been developed for an entire city include Basel, where an amendment to building regulations was introduced stating that all new and renovated flat roofs must be greened according to set design guidelines. In Faenza, a clause in the Town Planning Regulations allows developers to extend the volume of buildings in excess of approved standards if those buildings meet certain criteria of environmental sustainability (see section 4.8.4).

Legally binding regulations can also apply to specific areas in cities. For example, regulations in the Seattle Municipal Code referring to vegetation removal, maintenance and restoration, are only valid in areas of high landslide risk. In Stuttgart, different building and land use regulations are applicable to different areas according to the function of the area as identified by the Climate Atlas. In Berlin, the application of the Biotope Area Factor is limited to areas for which Landscape Plans exist. Dorset also provides an example of regulations applicable to tightly defined areas; developers only contribute financially to the heathland conservation programme if their development is located within a 400m-5km buffer set around protected heathland areas.

Tip: If the legal system in allows it, developing regulations for land use and buildings which enforce the implementation of green and blue space adaptation measures can be a very effective way of enhancing adaptation in practice. Regulations may only apply to specific zones in the city, where the adaptation actions are needed the most.

4.8.4 Use of subsidies and incentives

Regulations can be complemented with or substituted by subsidies and incentives promoting the use of green and blue space adaptation measures amongst developers and the general public. For example in Basel, subsidies proved hugely successful in increasing the coverage of green roofs in the city. In Berlin, the greening of the urban environment in the 1980s and 1990s was mainly implemented via financial incentives and grants for developers and residents. However, subsequent financial difficulties and a lack of funding mechanisms for the incentives (see below) led to the programme of direct financial incentives being replaced by a system of regulations.

Successful programmes involving incentives for greening of roofs and enhancing green open spaces are being implemented in Chicago and Faenza. In Chicago, the Green Permit Program encourages developers to include green roofs and other sustainable measures in the design of their buildings by offering them an expedited permit process, and in some cases even waving some fees, which results in significant financial savings to developers. In Faenza, planning conditions attached to each development site are negotiated between city planners and developers on case-by-case basis, and if the developer provides a satisfactory quality and quantity of green space, their buildings can increase in size beyond the level normally limited by the regulations.

Tip: The development and implementation of a subsidy or incentive programme, which would encourage the uptake of green and blue space adaptation measures by the developers and residents, can be a successful way of enhancing adaptation responses in practice. Identifying the stages of the planning permission process which provide the greatest obstacles for developers (often the amount of time involved), and trying to incentivise the use of adaptation measures by improving these elements of the planning process, could also prove to be a beneficial strategy.

4.8.5 Funding of adaptation actions

Subsidies, as the case of Berlin has shown, can prove to be costly and unworkable for cities to maintain in times of financial hardship. Several case studies provide examples of innovative sources of funding for adaptation initiatives which can help to address this problem. In Switzerland, 4% of all customers' energy bills are put into the Energy Saving Fund, which is then used to finance campaigns and measures to support energy savings. This fund was used in Basel to provide resources for subsidising the green roof programme.

In Dorset, the funding for mitigation of wildfires in urban heathland areas comes from contributions made by developers who apply for planning permission within a 400m to 5km buffer around protected heathland sites. In Seattle, some landslide mitigation actions are funded from the collection of drainage management fees. Also in Seattle, establishment of an interdepartmental team dealing with landslides made it possible to tap into different sources of money, significantly increasing the funding available for the initiative. Similarly, the City of Toronto created an interdepartmental Environmental Protection Reserve Fund for the purpose of funding the development of Toronto's long-term adaptation strategy.

The Seattle case study demonstrates that vertical collaboration between different levels of government can bring additional revenue. This was also achieved in the case of New Orleans; the State of Louisiana receives 37% of their revenues from newly opened oil and gas tracts, which are used to fund actions aiming at coastal restoration and protection.

Several of the case studies involved the use of the European Union funding in programmes leading towards the development of the adaptation initiatives (Slovakia, Dorset), directly for building adaptive capacity in the area (London Borough of Sutton), or for implementation of adaptation measures (Augustenborg in Malmö).

> **Tip:** Investigating the possibility of generating funds from environmental compensation programmes, for example from developers seeking to obtain planning permission in environmentally sensitive areas, can provide funding for adaptation responses. These can also be supported by sources of funding available for different departments in the organisation, from different levels of government, and from international sources.

4.8.6 Working alongside the stakeholders

Both new regulations and new incentives or subsidies programmes require close collaboration with relevant stakeholders (residents or developers). This may require the provision of additional information, such as Client Assistance Memos produced by the City of Seattle on the regulations relating to removal, maintenance and restoration of vegetation in landslide risk areas. In Faenza, the nature of the regulations means that the agreement on building volumes and the amount of green space offered in return by the developers is achieved through collaborative negotiations between city planners and the developers. Similarly in Chicago, the Green Permit Program involves close collaboration between the developers and the Department of Buildings in a process of developing consensus on building design.

> **Tip:** Establishing a clear and transparent process that guides residents and developers through programmes of subsidies, incentives, or regulations can improve their implementation. Setting up a dedicated team to deal with this process and to answer enquiries, and providing information about the initiatives avoiding jargon, can also support the adaptation process.

4.9 Monitoring and evaluation of success

Evaluation of the process leading to the development of adaptation initiatives was not common practice among the case studies explored. However, in Seattle, an external company was employed to evaluate the quality of the geological and climate evidence base compiled by the city, the US geological Survey and private companies. The effectiveness of the public campaign "The Netherlands Live with Water" is monitored in a continuous survey carried out by a market research company.

In the case of initiatives involving physical change, monitoring is relatively straightforward. For example in Malmö, it has been possible to measure the amount of stormwater going into the drainage system in Augustenborg prior to and after the implementation of the sustainable urban drainage systems. This can help to assess its effectiveness. However, in order to assess the success of a policy, an action plan or regulations, monitoring mechanisms need to be established in parallel with the development of the initiative.

Adaptation plans can facilitate the monitoring of their implementation if related actions have a clear aim and defined time frame, and if specific departments or organisations are accountable for delivering the action. This is the case in the North West Climate Change Action Plan in England, the adaptation strategy in Toronto, and for the New Orleans masterplan. Compliance with regulations regarding physical changes (e.g. characteristics of green roofs in Basel, adherence to the Biotope Area Factor regulations in Berlin, maintenance of vegetation in landscape-prone areas in Seattle, or contributions collected from developers in Dorset) can also be relatively easily checked.

Monitoring of success of a policy can be more difficult. In some cases, methods of evaluation of policies' effectiveness and sustainability at the local level are incorporated within national or regional policies (London Borough of Sutton). Absence of monitoring indicators at supra-organisational level can be solved by establishment of clear targets locally. For example in Nagoya, the Biodiversity Strategy aims at increasing the percentage of green space to 40%, and at increasing the rainwater infiltration rate to 33%.

Tip: Employing an external party to evaluate the process leading to development of the adaptation initiative can provide valuable information. Investigating which of the adaptation initiative's outcomes are measurable, and setting up the mechanisms to measure them, can also be helpful. Similarly, when developing policies, setting clear targets against which the progress can be measured will support monitoring. Action plans should specify time frames for completion of tasks and identify organisations accountable for delivery of the tasks.

Appendix 1 Short case studies

Living roofs in London, UK

City	*Region*	*Country*
London	South East	UK

Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	**Storm events**
Fire events	**Poor air quality**	**Biodiversity change**	

Scale	*Stage*	*Source of funding*
Town or city	Ongoing	Regional government; local authorities; private sector

Activities involved		
Physical infrastructure change	**Change in spatial planning policy**	**Stakeholder engagement**
Organisational change	**Change in legislation or regulation**	**Research into the need for adaptation**
Educational action	Financial action	

Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	Recreation	Water management
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development			

Leading agent	*Key stakeholders*
Non-governmental organisation: Livingroofs.org	Regional government; local authorities; NGOs; research institutions; community/citizens

Project description
The original idea of the work, which started in 1997, was to promote installation of green roofs for biodiversity enhancement and conservation. In 2004, livingroofs.org was officially established as a driver to get policy changes into the London Plan. Since then, over 500,000m^2 of green roofs has been installed in London, mainly as a result of retrofitting action. As a result of the championing actions, the 2008 London Plan includes a policy on Living roofs and walls (Policy 4A.11; http://www.london.gov.uk/thelondonplan/policies/4a-11.jsp).

Also, two PhD projects were initiated and collaborated on, addressing green roofs and biodiversity and green roofs and recycled aggregates. The NGO is now working closely with the Institute for Sustainability (http://www.instituteforsustainability.co.uk/) to establish a research station to measure the impact of green roofs on the urban heat island, water quality, and stormwater management. Monitoring of biodiversity on green roofs has been carried out since 2001 and a comprehensive data set has been compiled.

In addition, Livingroofs.org also provide training on green roof installation and maintenance to both the public and the private sectors, in addition to community groups.

Good practice includes:
- Prioritising adaptation
- Sound evidence base
- Leadership / championship

Resources
http://www.livingroofs.org/
www.dustygedge.co.uk
www.greenrooftraining.co.uk
www.greenroofconsultancy.com

Contact
Mr Dusty Gedge, Livingroofs.org; dusty@dustygedge.co.uk; Tel: +44(0)7977202373

WaterProof Northwest, UK

City	*Region*	*Country*
Manchester	North West	UK

Adaptation to climate change impacts			
River flooding	**Urban flooding**	**Sea level rise**	Ground instability
Drought	**Heat waves**	**Water quality**	**Storm events**
Fire events	Poor air quality	Biodiversity change	

Scale	*Stage*	*Source of funding*
Region	Completed (March 2010)	Regional branch of a national body (Environment Agency); and private sector (United Utilities)

Activities involved		
Physical infrastructure change	Change in spatial planning policy	**Stakeholder engagement**
Organisational change	Change in legislation or regulation	Research into the need for adaptation
Educational action	Financial action	

Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	Recreation	**Water management**
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	**Planning**		

Leading agent	*Key stakeholders*
Non-governmental organisation: Mersey Basin Campaign; research institution: University of Manchester	Local authorities; NGOs; research institutions; community/citizens

Project description

The Mersey Basin Campaign (MBC) carried out a project engaging local authorities in the delivery of the EU's Water Framework Directive (WFD) in partnership with the University of Manchester. The project used the method of scenario planning to identify the challenges and opportunities that could impact on delivery of the WFD in the Northwest of England. The overall aim of the project was to produce four contrasting scenarios for the year 2030 that could be used to facilitate better planning and decision-making in relation to the future management of the region's water environment.

Drivers of change that could impact on society and the environment over the next 20 years were identified through roundtable meetings and interviews with key stakeholders. These drivers helped to inform the scenario prototypes, together with a large amount of desktop research. Further consultation was then undertaken to assess the prototype scenarios and their accompanying images. An interactive display was produced which featured a brief summary of each scenario and their accompanying images. The display board was taken to various events and people were asked to cast a vote as to which scenario they felt was the most likely vision for the Northwest region in 2030. This display board was also a valuable tool for raising awareness of the issues and promoting the project to a wider audience. The University of Manchester then produced the final scenarios and the results were disseminated via a half-day event and a final report.

Good practice includes:

- Sound evidence base
- Positively influencing decision making

Resources

www.waterproofnorthwest.org.uk
http://www.merseybasin.org.uk/archive/assets/239/original/WaterProof_Northwest.pdf

Contact

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Supermarket Adaptation to Future Environments, UK

City	*Region*	*Country*
Greater Manchester conurbation	North West	UK

Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	**Storm events**
Fire events	**Poor air quality**	Biodiversity change	

Scale	*Stage*	*Source of funding*
Building	Completed	Private sector (Tesco)

Activities involved		
Physical infrastructure change	Change in spatial planning policy	**Stakeholder engagement**
Organisational change	Change in legislation or regulation	**Research into the need for adaptation**
Educational action	Financial action	

Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	Recreation	Water management
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	Planning		

Leading agent	*Key stakeholders*
Research institution: University of Manchester	Local authorities; private sector; NGOs; research institutions; community/citizens

Project description

The Supermarket Adaptation to Future Environments (SAFE) project was funded by Tesco through the Sustainable Consumption Institute (SCI) at the University of Manchester. This project aimed to inform the development of the next generation of supermarkets by developing and analysing future environmental scenarios so that supermarkets and their associated infrastructure can adapt to climate change and be better integrated into the local environment. The study focussed on the external environment of stores and assessed measures to adapt the external environment to climate change. The project involved:

- Investigating examples of good practise in adaptation to climate change already implemented in supermarkets and within the retail sector more widely; and holding two workshops with representation from a number of stakeholders, including the private sector, NGOs, local authorities and research institutions.
- Environmental monitoring of case study stores to investigate the current state of stores and their environments (neighbourhoods). This also included a public survey on human comfort. Environmental modelling was then carried out to investigate different potential adaptation measures to reduce surface temperatures at the site and in the wider neighbourhood, including adding green roofs, greening car parks, and ponds.

The project illustrates engagement of the private sector through funding the initiative and involvement at workshops. In addition, full access to the sites for environmental monitoring was given. The research was undertaken to influence the design of future Tesco supermarkets as well as identifying measures that could be retro-fitted to existing stores.

Good practice includes:

- Sound evidence base
- Prioritising adaptation
- Positively influencing decision making

Resources

Full report: http://www.sci.manchester.ac.uk/medialibrary/SAFE_Final_Jan09_reduced.pdf

Contact

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Guiding models for water storage, The Netherlands

City	*Region*		*Country*
Arnheim, Nimwegen, Tiel	Area between rivers Rhine and Meusse		The Netherlands
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	Heat waves	Water quality	Storm events
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Town or city	Completed	European Union and local Water Board	
Activities involved			
Physical infrastructure change	**Change in spatial planning policy**	**Stakeholder engagement**	
Organisational change	Change in legislation or regulation	**Research into the need for adaptation**	
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	Recreation	**Water management**
Biodiversity conservation	Transport	**Urban regeneration**	Housing
Private sector development	Planning		
Leading agent		*Key stakeholders*	
		Regional government; Local authorities; community/citizens	

Project description

The Guiding Models for Water Storage were developed to assist water managers and spatial developers in weaving together water storage with other functions. Water storage is defined as the retention and salvaging of water by modifying the spatial plan of an area to create more room for water. Strategies such as intensification, combining space use, different dimensions of land use, switching in time and transformation can improve land use. The importance of water storage can be relevant in many occasions throughout the planning process. The following phases can be distinguished: initiative, design and development, decision making, testing, executing, and monitoring and evaluation. The water manager can exert influence on the outcome within every phase of the policy cycle. To have an impact, the water manager has to be able to transfer the sense of urgency to the relevant institutions and the residents in an area. Another important instrument for the water manager within spatial planning is force field analysis. To have influence in the process, it is important to maintain the right perspective on the roles and positions of different actors. An understanding of the underlying interests of the actors and a discussion on what one is trying to achieve tends to create more room for new solutions, coalitions and compromise.

The Norm Study is implemented once the theoretical Guiding Models are put into practice. A specific area was selected to influence spatial planning with stakeholders. Firstly, the exact water amount was calculated using a hydrological model, and keeping safety levels in mind, the exact water storage levels required was determined. This was carried out with the stakeholders and therefore they also felt a sense of urgency to solve the problem. A Communication Tool ensured that everyone was discussing the same issue and a shared mindset was created. Within the project, several adaptation measures were suggested and planned. Although the actual measures may still be difficult to implement, there has been a sound discussion on the issue.

Good practice includes:

- Prioritising adaptation
- Sound evidence base
- Cohesive delivery of multiple benefits

Resources

www.espace-project.org/part1/publications/pdf8.pdf

I-trees research project, Manchester, UK

City	*Region*	*Country*
Manchester	North West	UK

Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	Storm events
Fire events	**Poor air quality**	Biodiversity change	

Scale	*Stage*	*Source of funding*
Town or city	Ongoing	European Union; Local authorities

Activities involved		
Physical infrastructure change	Change in spatial planning policy	Stakeholder engagement
Organisational change	Change in legislation or regulation	**Research into the need for adaptation**
Educational action	Financial action	

Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	Recreation	Water management
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	Planning		

Leading agent	*Key stakeholders*
Non-governmental organisation (Red Rose Community Forest) and research institution (University of Manchester and Manchester Metropolitan University)	Local authorities; NGOs; Research institutions; community/citizens

Project description

The I-trees project explores the impact of different land surface types on surface water run-off and surface temperature. Nine Experimental Monitoring Plots have been set up in a highly urbanised area close to Manchester city centre. The plots include a 3x3m^2 grass plot; a 3x3m^2 tarmac plot; and a 3x3m^2 plot with a tree. The plots contain monitoring devices which capture temperature and surface water run-off data that will be analysed to determine the effectiveness of green infrastructure over sealed surfaces to assist in adaptation to high temperatures and pluvial flooding. It is hoped that the research from this project will demonstrate the importance of green infrastructure over sealed surfaces and will help to quantify the amount of green infrastructure needed to assist in climate proofing cities.

I-trees is being co-ordinated by Community Forests North West and the University of Manchester. The project is supported by a steering group of academic staff from the fields of Planning and Landscape, Life Sciences, Earth Atmospheric and Environmental Sciences, Architecture and Geography, as well as representatives from Manchester City Council, Manchester City South Partnership, Red Rose Forest and Mersey Forest. With further funding, it is envisaged that the project will grow into its second and third phases which will include street level climate monitoring stations and observatories for members of the public. In addition, a considerable investment will go into providing additional trees and greenery to enhance the quality of the local environment and image of the area. At the end of the project, the published research will be used to influence policy and resource allocation, by demonstrating the need for tree planting schemes along major transport corridors.

Good practice includes:

- Prioritising adaptation
- Sound evidence base
- Positively influencing decision making

Resources

http://www.sed.manchester.ac.uk/architecture/research/ecocities/projects/associatedprojects/associated_projects_%20itree.pdf

Contact

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Community Climate Change Action Plan, Salford, UK

City	*Region*		*Country*
Salford	North West		UK
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	**Storm events**
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Neighbourhood	Inception	Central government; Local authorities; private sector	
Activities involved			
Physical infrastructure change	Change in spatial planning policy		**Stakeholder engagement**
Organisational change	Change in legislation or regulation		**Research into the need for adaptation**
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	**Mitigation of climate change**	Recreation	Water management
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Local authorities – Salford City Council		Central government (represented by the Environment Agency); politicians; private sector; NGOs; research institutions; community/citizens	

Project description

The aim of the project is to make communities in the floodplain of the River Irwell resilient to impacts of climate change. The initiative was originally conceived as a project to encourage take-up of flood resilience measures in households in the floodplain. The intention is to test the propensity to take up such measures within an overall strategy of adaptation and mitigation. In other words, will greater awareness of climate change and its consequences lead to a greater take up of flood resilience measures?

The project is funded by the Environment Agency. Phase 1 of the initiative, which identifies the key partners and the most effective means of community participation, is already complete. Phase 2 will focus on delivery which includes the installation of flood resistance measures in both private and social housing. It will also include an analysis of green infrastructure and a programme delivered by Red Rose Community Forest and Groundwork, who will also examine the possibility of replacing impermeable driveways with green infrastructure. Partnerships between housing providers and energy companies will address mitigation issues. In addition, Salford University has been carrying out research into behavioural change and Salford City Council's environmental education service has been working with primary schools in the area to promote awareness.

Good practice includes:

- Prioritising adaptation
- Cohesive delivery of multiple benefits
- Positively influencing decision making

Resources

http://www.salixhomes.org/2318.htm
http://www.environment-agency.gov.uk/news/108962.aspx

Contact

Chris Findley, Salford City Council
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Green roofs on all new developments, Sheffield, UK

City	*Region*		*Country*
Sheffield	Yorkshire and the Humber		UK
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	Heat waves	**Water quality**	**Storm events**
Fire events	**Poor air quality**	**Biodiversity change**	
Scale	*Stage*	*Source of funding*	
City	Ongoing	Private sector	
Activities involved			
Physical infrastructure change	Change in spatial planning policy		**Stakeholder engagement**
Organisational change	**Change in legislation or regulation**		Research into the need for adaptation
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	**Mitigation of climate change**	Recreation	**Water management**
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Local authorities – Sheffield City Council		Research institution (University of Sheffield)	

Project description

The implementation of green and vegetated roofs through local authority planning requirements on all new medium to large developments. Green roofs are supported by Sheffield City Council for all of their many benefits but primarily for wildlife and rainwater attenuation.

The Green Roof Centre at the University of Sheffield has helped Sheffield City Council to establish its minimum desirable standards and planning condition strategy.

Good practice includes:

- Prioritising adaptation
- Leadership / championship
- Positively influencing decision making

Resources

www.thegreenroofcentre.co.uk

Contact

Victoria Sims
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Stamford Brook: naturalised river in Altringham, UK

City	*Region*		*Country*
Altringham, Greater Manchester	North West		UK
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	Heat waves	Water quality	Storm events
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Neighbourhood	Completed	Regional government; private sector; NGO	
Activities involved			
Physical infrastructure change	**Change in spatial planning policy**		**Stakeholder engagement**
Organisational change	**Change in legislation or regulation**		Research into the need for adaptation
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	**Mitigation of climate change**	Recreation	**Water management**
Biodiversity conservation	Transport	Urban regeneration	**Housing**
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Non-governmental organisation – National Trust		Local authorities; private sector; research institutions; community/citizens	

Project description

Stamford Brook in Altrincham, Greater Manchester is a new-build estate of over 700 houses on National Trust land. For the first phase of construction, the Trust worked with volume housebuilders and Leeds Metropolitan University to design, build and test mainstream homes which are as energy efficient as possible. The lessons learnt have influenced the normal practice of the housebuilders as well as national Building Regulations. As the houses were to be built within a flood risk zone, the canalised river running through the estate was naturalised and a SUDs system was included in the landscaping. This has reduced the flood risk to the new properties as well as homes on the neighbouring estates.

The work on energy efficiency has influenced the development of national building regulations. Working with the local authority and Environment Agency has led them to recommend the approach used at Stamford Brook as good practice for other estates built in a flood risk area. A significant amount of public engagement took place before the development to reassure local communities about the effects of river naturalisation and to prove that it would reduce flood risk to their homes.

Good practice includes:

- Prioritising adaptation
- Leadership / championship

Resources

http://www.nationaltrust.org.uk/main/w-global/w-news/w-news-further_news/w-news-delivering-sustainable_housing.htm

Contact

Joanna Pugh
National Trust
joanna.pugh@nationaltrust.org.uk

Engaging community in urban forest planting, Telford, UK

City	*Region*		*Country*
Telford and Wrekin	East Midlands		UK
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	**Ground instability**
Drought	**Heat waves**	Water quality	Storm events
Fire events	**Poor air quality**	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Neighbourhood	Ongoing	Local authorities; Seeking Community Grants	
Activities involved			
Physical infrastructure change	**Change in spatial planning policy**		**Stakeholder engagement**
Organisational change	Change in legislation or regulation		**Research into the need for adaptation**
Educational action	**Financial action**		
Themes driving the initiative			
Adaptation to climate change	**Mitigation of climate change**	**Recreation**	Water management
Biodiversity conservation	Transport	**Urban regeneration**	Housing
Private sector development	Planning	**Crime reduction**	
Leading agent		*Key stakeholders*	
Local authorities		Politicians; NGOs; Research institutions; community/citizens	

Project description

The aim of the initiative was to firstly establish areas within the Borough which have limited urban forestry, as well as poor community health and high crime, and then, to engage the communities in these areas in designing and planting urban trees to ameliorate their area from these aspects but also to encourage wildlife, meet carbon offsetting targets, improve shade, aesthetics and reduce noise.

Shropshire Wildlife Trust developed a proposal to engage communities in urban forestry. A local Borough Council became interested in the proposed approach, and support from key politicians and officers was secured. Partner organisations were then engaged through a series of meetings to establish interest in and relevance of the proposal, followed by potential areas for implementation, a suitable methodology, and resources. This has led to the mutual recognition of potential improvements for a variety of organisations towards social biodiversity and climatic benefits.

Good practice includes:

- Sound evidence base
- Leadership / championship
- Setting up an efficient organisational structure to deliver adaptation responses
- Positively influencing decision making
- Cohesive delivery of multiple benefits

Contact

Tom Currie
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2BG: Black, Blue and Green research project in Denmark

City	*Region*		*Country*
Copenhagen	Zealand		Denmark
Adaptation to climate change impacts			
River flooding	**Urban flooding**	**Sea level rise**	Ground instability
Drought	Heat waves	**Water quality**	Storm events
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Neighbourhood	Ongoing	Local authorities	
Activities involved			
Physical infrastructure change	**Change in spatial planning policy**	**Stakeholder engagement**	
Organisational change	Change in legislation or regulation	**Research into the need for adaptation**	
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	**Recreation**	**Water management**
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Local authorities and research institutions		Local authorities and research institutions	

Project description

The City of Copenhagen is developing a plan for adaptation to climate change. In parallel, the research project 2BG – Black, Blue and Green, is being carried out by the Danish Centre for Forest, Landscape and Planning at the University of Copenhagen, which is exploring the role of green infrastructure for stormwater retention and infiltration. The project is being carried out in close cooperation with the city with a view towards implementing the research findings. The project is funded by national research councils and co-funded by local authorities and private consultancies. The climate change adaptation plan, which emphasises the need for adaptation to sea level rise, is fully funded by the Copenhagen municipality.

The 2BG project explores the possibility for a paradigm shift within urban water systems, a shift that focuses on citizens' life quality and long-term functionality of applied management concepts. The 2BG key-challenges for stormwater are to analyse the potential for massive infiltration to avoid sewer overflow and to recharge local streams and aquifers; the methods for water quality control to avoid pollution of receiving environments and improve re-use opportunities, and the options for inclusion of technical water systems as assets in urban life.

2BG outputs will include: a model for simulating urban water flows in response to increased infiltration, IT-tools for city-level dimensioning of stormwater infiltration, evaluation of catchment policies and end-of-pipe options for control of water quality, and support-tools for integrating urban water systems within green infrastructure. Events to enhance the transfer of knowledge between urban planners, engineers and landscape architects will be organised.

Good practice includes:

- Prioritising adaptation
- Sound evidence base

Resources

www.2BG.dk
http://www.kk.dk/sitecore/content/Subsites/CityOfCopenhagen/SubsiteFrontpage/InformationAndServices/ClimateAndEnvironment.aspx

Contact

Marina Bergen Jensen, mbj@life.ku.dk

Dry Feet for Tiel East project, the Netherlands

City	*Region*		*Country*
Tiel	Provincie Gelderland		The Netherlands
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	Heat waves	Water quality	**Storm events**
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Neighbourhood	Inception	European Union	
Activities involved			
Physical infrastructure change	**Change in spatial planning policy**		**Stakeholder engagement**
Organisational change	Change in legislation or regulation		**Research into the need for adaptation**
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	Recreation	**Water management**
Biodiversity conservation	Transport	**Urban regeneration**	**Housing**
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Local authorities		Regional government; local authorities; private sector; research institutions; community/citizens	

Project description

Tiel East is a business site between Waal and Amsterdam-Rhine canal, which has to cope with water related problems such as runoff management, groundwater table fluctuations and water seepage from the river and the canal. Development of 1100 new houses is underway at Tiel East. However, at present, all building activities have been stopped because new development would create even more problems for the surrounding area.

"Dry feet for Tiel East" is a pilot project within the Future Cities Interreg IVB project. The key components of the project include development of an integral scenario for water for Tiel East, combining innovative design principles and technical measures to solve several water related problems; transforming industrial roofs into green roofs on a large scale; and, education on adapting to climate change.

The project is being carried out in a participatory manner with the Tiel East residents. As part of the project, a Watergame has been developed in which the roles of stakeholders (municipality, water boards, project developers, housing associations, and inhabitants) can be played. The game has proven useful as it lets stakeholders play each others role: this enhances the insights into the different aims that each stakeholder has and therefore, results in a better understanding of decisions that have to be made.

Good practice includes:

- Prioritising adaptation
- Sound evidence base
- Setting up an efficient organisational structure to deliver adaptation responses
- Achieving integrated adaptation responses across the organisation
- Positively influencing decision making

Resources

http://www.future-cities.eu/index.php
http://www.future-cities.eu/project/pilot-projects-locations/tiel-nl/1.html
http://www.watergame.nl/Welkom.html

Contact

Municipality of Tiel
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Newlands: greening the brownfield land in Northwest England

City	*Region*	*Country*
Manchester, Liverpool, Preston	North West	UK

Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	**Ground instability**
Drought	**Heat waves**	Water quality	**Storm events**
Fire events	**Poor air quality**	Biodiversity change	

Scale	*Stage*	*Source of funding*
Region	Ongoing	Regional government

Activities involved		
Physical infrastructure change	Change in spatial planning policy	**Stakeholder engagement**
Organisational change	Change in legislation or regulation	Research into the need for adaptation
Educational action	**Financial action**	

Themes driving the initiative			
Adaptation to climate change	**Mitigation of climate change**	Recreation	Water management
Biodiversity conservation	Transport	**Urban regeneration**	Housing
Private sector development	Planning	**Economic/social regeneration**	

Leading agent	*Key stakeholders*
Regional government (North West Development Agency)	Regional government; local authorities; private sector; NGOs; community/citizens

Project description

Launched in the summer of 2003, Newlands is a unique regional £59 million scheme that responds to local and regional socio-economic needs by transforming derelict sites - often former landfill or industrial sites that exist in the centre of urban areas (many of which are socially deprived) - into thriving, multifunctional community woodlands. Newlands is helping to combat the effects of climate change such as flooding and the urban heat island effect, by planting trees and shrubs both on site and also in surrounding areas, carefully planning hard landscaping, and selecting the most appropriate (often porous) surfaces.

Newlands works through partnerships; most notably partnerships between the Northwest Regional Development Agency (NWDA) and the Forestry Commission. The project uses The Public Benefit Recording System – a tool to identify land where regeneration will deliver maximum environmental economic and social benefits. Each Newlands site has 15 years of management funding and a 99 year lease to ensure that they remain in good condition over the long term. During the first phase of the project (2003-10) seven brownfield sites (345ha) have been transformed in the Mersey Belt area. The second phase of investment, which applies the programme across the whole of the Northwest Region, will be delivered in 2010-15.

Good practice includes:

- Prioritising adaptation
- Leadership / championship
- Setting up an efficient organisational structure to deliver adaptation responses
- Achieving integrated adaptation responses across the organisation
- Positively influencing decision making

Resources

www.newlandsproject.co.uk; www.forestry.gov.uk/newlands
Public Benefit Recording System: http://www.pbrs.org.uk/

Contact

Faith Ashwiorth, Creative Concern, Manchester: faith@creativeconcern.com

Green-blue corridor in the city of Kamen, Germany

City	*Region*		*Country*
Kamen	Northrhine-Westphalia		Germany
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	Storm events
Fire events	**Poor air quality**	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Neighbourhood	Ongoing	European Union; Water Board	
Activities involved			
Physical infrastructure change	Change in spatial planning policy		**Stakeholder engagement**
Organisational change	Change in legislation or regulation		Research into the need for adaptation
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	Recreation	**Water management**
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	Planning	**Visual attractiveness**	
Leading agent		*Key stakeholders*	
Lippeverband		Community/citizens	

Project description
Lippeverband is a Water Board founded in 1926 in order to solve the problems caused by increasing industrialization and volumes of sewage, hygiene problems including epidemics, and underground coal mining in the Lippe catchment in North-Rhine-Westphalia. Lippeverband is a partner in the INTERREG IV B Project Future Cities, and it aims to develop a green-blue corridor through the city of Kamen, Germany.

Lippeverband in Kamen operates an open water course, the Heerener Mühlbach (length 2.14 km, total catchment area 1,470 ha), for the collection of waste water to the next biological waste water treatment plant. One of the main tasks of the Lippeverband is to restructure the whole area and to improve water quality inside the receiving water. The water body of the Heerener Mühlbach will be ecologically improved, the concrete bed will be removed and the hard banks will be modified into natural banks. In addition, the paved areas nearby (about 80 houses and properties with a total paved area of 1.1 ha), which feed the combined sewer system will be disconnected and the stormwater will be drained into a new, water body of more natural character. The majority of the cost for disconnection (10-25 €/m² for infiltration facility and open water drain) will be paid by the residents. The citizens will be made aware of what they can do personally to face climate change and to improve the city climate - such as disconnecting their private property.

A green-blue corridor will be created to contribute to adaptation to climate change by reducing the risk of flooding, improving water cycling and providing cooling through evaporation and evapotranspiration.

Good practice includes:
- Prioritising adaptation
- Achieving integrated adaptation responses across the organisation
- Positively influencing decision making

Resources
www.future-cities.eu

Contact
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Lippeverband
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EcoCities: developing an adaptation blueprint for Greater Manchester, UK

City	*Region*	*Country*
Greater Manchester	North West	UK

Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	**Storm events**
Fire events	Poor air quality	Biodiversity change	

Scale	*Stage*	*Source of funding*
City-region	Ongoing	Charitable donation from private sector

Activities involved		
Physical infrastructure change	Change in spatial planning policy	**Stakeholder engagement**
Organisational change	Change in legislation or regulation	**Research into the need for adaptation**
Educational action	Financial action	

Themes driving the initiative			
Adaptation to climate change	**Mitigation of climate change**	Recreation	Water management
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	Planning		

Leading agent	*Key stakeholders*
Research institution – University of Manchester	Local authorities; private sector

Project description

EcoCities is an initiative led by the University of Manchester and funded by Bruntwood, drawing on the expertise of the Manchester Architecture Research Centre (MARC), Centre for Urban Regional Ecology and Brooks World Poverty Institute. The project will focus on the response of urban areas to the impacts of climate change, looking particularly at how we can adapt our cities to the challenges and opportunities that a changing climate presents. In particular, EcoCities focuses on the use of green and blue infrastructure to reduce the vulnerability of cities to flooding and high temperatures.

EcoCities seeks to provide Manchester, by the end of 2011, with its first blueprint for an integrated climate change adaptation strategy. This will be based on leading scientific research, extensive stakeholder engagement, and best practice examples of new programmes successfully piloted during a three-year period.

Good practice includes:

- Positively influencing decision making
- Sound evidence base

Resources

www.manchester.ac.uk/ecocities

Contact

ecocities@manchester.ac.uk

Creating coherent green infrastructure in Budapest, Hungary

City	*Region*		*Country*
Budapest			Hungary
Adaptation to climate change impacts			
River flooding	Urban flooding	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	Storm events
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Neighbourhood	Ongoing	Local authorities; private sector	
Activities involved			
Physical infrastructure change	**Change in spatial planning policy**	**Stakeholder engagement**	
Organisational change	Change in legislation or regulation	**Research into the need for adaptation**	
Educational action	**Financial action**		
Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	**Recreation**	Water management
Biodiversity conservation	Transport	**Urban regeneration**	Housing
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Local authorities		Private sector; NGOs; community/citizens	

Project description

The main goal of AngelGREEN (AngyalZÖLD) Green Network Development Strategy of the 13th district of Budapest is to integrate the various elements of public and semi-public urban spaces into a coherent network of patches and linear elements. The patches include large and small urban parks, amenity areas associated with housing estates, school grounds, and sports and play areas. The linear elements include the corridors along rivers and streams (Danube or Rákos), greenways, and tree alleys. The main aim is to increase the number and improve the condition and connectivity of these elements. The secondary aim is to improve the communication between the Local Authority and the residents, involve them in the decision making process, and in the creation and maintenance of urban greenery. Therefore, the project aims to develop a partnership approach towards green network development.

The Strategy includes the following programmes:
- Urban park and public green space (improvement of their safety and aesthetics)
- Green corridor, greenway and alley (improving the connectivity of the network)
- Institutional gardens (improvement of school and nursery grounds)
- Environment management (improvement of the maintenance of urban green spaces, including adaptation measures)
- Communication and partnership
- Changing the regulations on the maintenance and management of green networks

Good practice includes:

- Sound evidence base
- Positively influencing decision-making
- Public engagement

Resources

http://www.angyalzold.hu/web/index.php (in Hungarian only)

Contact

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SUDS in Upton One development, Northampton, UK

City	*Region*		*Country*
Northampton	East Midlands		UK
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	Heat waves	Water quality	Storm events
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Neighbourhood	Completed	Regional government; Local authorities; private sector	
Activities involved			
Physical infrastructure change	Change in spatial planning policy	**Stakeholder engagement**	
Organisational change	Change in legislation or regulation	**Research into the need for adaptation**	
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	**Mitigation of climate change**	Recreation	**Water management**
Biodiversity conservation	Transport	Urban regeneration	**Housing**
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Local authorities		Central government; regional government; community/citizens	

Project description

The need for new housing in Northampton led to the development of high density housing on a large site on the edge of the flood plain. Northampton had experienced severe flooding in 1998, and it was crucial that there should be no future risk of flooding, even in the face of climate change. The project also presented an opportunity to test green technologies for the future delivery of national housing targets. A design code agreed and adopted by the Local Authority set standards for developers to ensure that proposals were of high quality, environmentally sound, and recognisably of Northampton. Development bids were endorsed by a steering group of political and community representatives. Advance infrastructure was provided by English Partnerships, fast tracking the development whilst also maintaining a high quality public realm. This included an innovative sustainable urban drainage system (SUDS), open space playing fields, and a road network.

On-site SUDS have worked successfully and are very popular with residents as play spaces. In addition, the reed beds that form part of the system provide a valuable habitat for wildlife. The Upton project promotes best practice well ahead of government standards. A strong partnership approach to design and development guarantees support from all the key agencies, including the local residents.

Good practice includes:

- Prioritising adaptation
- Leadership / championship
- Internal collaboration

Resources

http://showcase.hcaacademy.co.uk/case-study/upton-sustainable-urban-extension.html#background http://www.cabe.org.uk/case-studies/upton-phase-one/design

Contact

Northampton Borough Council
www.northampton.gov.uk

A park above an underground carpark: Liverpool, UK

City	*Region*		*Country*
Northampton	East Midlands		UK
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	Storm events
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Building	Completed	Private sector	
Activities involved			
Physical infrastructure change	Change in spatial planning policy	Stakeholder engagement	
Organisational change	Change in legislation or regulation	Research into the need for adaptation	
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	Mitigation of climate change	Recreation	Water management
Biodiversity conservation	Transport	**Urban regeneration**	Housing
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Private sector		Local authorities	

Project description

Chavasse Park was the largest green space in Liverpool City Centre. The Paradise Project resulted in extensive redevelopment of the area, with the park replaced by an extensive underground car park and retail centre. However, the park was then reinstated on top of the new development, ensuring the continued provision of greenery in the area. It is a 2.2 hectare park attached to the Liverpool One development. The park undulates, and rises up from 6.5m to 18m above sea level. The park is privately managed, and is part funded by the car park on which it sits. The new-look Chavasse Park has won awards including the British Association of Landscape Industries Grand Prize at the National Landscape Awards in 2008 and was highly commended by the Landscape Institute Awards in 2009.

To prevent flooding of the car park below the park, slow percolation is encouraged. Laser-cut polystyrene blocks occupy the space between the car park and the substrate. Above this, a light expanded clay capable of retaining and slowly discharging water is overtopped with a sand-based subsoil and manufactured topsoil. Since evapotranspiration reduces in drought conditions, the park has been designed to attenuate rainwater onsite. Specially constructed cells and a water harvesting tank retain water onsite to irrigate the park in periods of drought so it can continue to cool the city air.

Good practice includes:

- Prioritising adaptation

Resources

http://www.hortweek.com/news/search/863002/Waterfront-reinvention---Liverpool-ONE/
www.liverpoolpsda.co.uk/NR/exeres/EADA5068-F340-4053-A810-C15BAF22E0D7.htm
http://bdp.com/News/2008/BALI-Grand-Prize-for-Chavasse-Park/
http://www.guardian.co.uk/society/2001/jan/16/urbandesign.communities
http://www.cabe.org.uk/design-review/chavasse-park

Contact

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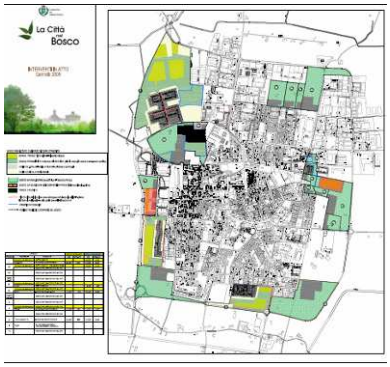
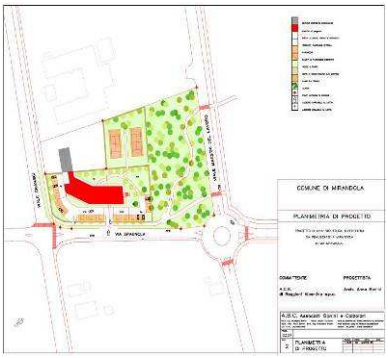
Development of urban green belt: Mirandola, Italy

City	*Region*		*Country*
Mirandola	Emilia Romagna		Italy
Adaptation to climate change impacts			
River flooding	**Urban flooding**	Sea level rise	Ground instability
Drought	**Heat waves**	Water quality	Storm events
Fire events	Poor air quality	Biodiversity change	
Scale	*Stage*	*Source of funding*	
Building	Completed	Private sector	
Activities involved			
Physical infrastructure change	**Change in spatial planning policy**	**Stakeholder engagement**	
Organisational change	Change in legislation or regulation	Research into the need for adaptation	
Educational action	Financial action		
Themes driving the initiative			
Adaptation to climate change	**Mitigation of climate change**	Recreation	Water management
Biodiversity conservation	Transport	Urban regeneration	Housing
Private sector development	Planning		
Leading agent		*Key stakeholders*	
Local authorities		Local authorities; Regional authorities; Citizens	

Project description

The Local Energy Plan of the municipality of Mirandola aims to achieve 20% energy reduction by 2020. One of the measures to achieve this aim is the creation of a green belt around the city to provide cooling and shading in summer. The green belt of 200ha in size is achieved using the instrument of "transfer of development rights", where the developers receive permission to increase the size of their buildings if they commit a significant part of their land to green space (see images below). The individual green spaces form a continuous green belt. The green belt has additional benefits of reducing the risk of urban flooding, and improving the quality of life of Mirandola's residents. The use of flexible and negotiable standards for developments promotes engagement of developers in town planning and shortens the wait for planning permission.





Good practice includes:

- External collaboration
- Innovative approach

Resources

http://www.bioecolab.it/comuni_MO/Mirandola.pdf
http://www.territorio.provincia.modena.it
http://www.provincia.modena.it/allegato.asp?ID=41749

Acknowledgements

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Appendix 2 Other sources of case studies and good practice

Author or host URL	Title	Thematic scope	Geographical scope	Details
Greenroofs.com http://www.greenroofs.com/projects/	International green roof and green wall database	Green roofs and green walls	International, but mainly USA	The database is fully searchable by location, green roof/wall properties, designer/manufacturer, building type, accessibility and keywords. The case studies offer the above information, plus photographs, plans and/or short descriptions. The database is open for submission of the projects and in June 2010 it included over 1,000 projects (predominantly from the USA).
Environment Agency, UK http://www.environment-agency.gov.uk/research/planning/108348.aspx	Climate change adaptation case studies	A range of adaptation issues beyond green and blue spaces	UK	The case studies show how the Environment Agency is working with partner organisations across England and Wales to plan for adaptation and protect people and places. The database is searchable by region and by categories: flooding, land use planning, sea level rise and coast, wildlife and habitats, communities and people, land management, water resources, and business and industry. The case study includes a description of the initiative, and lists partners involved. This is accompanied by visual materials and links to documents.
Commission for Architecture and the Built Environment, UK http://www.sustainablecities.org.uk/good_practice/	Sustainable cities	Common sustainability themes	International, mainly UK	The database contains both advice and examples of sustainable solutions in themes such as energy, green infrastructure, public space, transport, waste and water. It can be searched by common themes, spatial scales or advice/example character. The most useful information about green and blue spaces can be found by looking at themes of green infrastructure and water.
Commission for Architecture and the Built Environment, UK http://www.cabe.org.uk/case-studies	Case studies	Examples of best planning and design of buildings and open spaces	International, mainly UK	Includes hundreds of the best buildings and places in the country, from large-scale plans for city centres to shops and theatres. Searchable by keywords, e.g. "green infrastructure". Description of the case studies is detailed and includes background, process, evaluation and further information about the project.
Department for Communities and Local Government, UK http://www.communities.gov.uk/publications/planningandbuilding/pps25guideupdate	Planning Policy Statement 25: Development and Flood Risk. Good practice guide	Examples of planning decisions and initiatives associated with requirements of PPS25	England and Wales	While the guide is meant to support decisions of the local authorities in England and Wales, it provides good case studies on the use of green and blue infrastructure that can be useful to planners outside the UK.
Danish Architecture Centre http://www.sustainablecities.dk	Sustainable Cities	Sustainable urban planning	World	The database provides best practice case studies on sustainable urban planning. It is searchable by the following categories: buildings, education, energy, food production, green city, master plans, social issues, transportation, waste and water. All categories include examples of climate change adaptation actions.

Author or host URL	Title	Thematic scope	Geographical scope	Details
Community Forests Northwest, UK http://www.greeninfrastructurenw.co.uk/climatechange/search_start.php	Green Infrastructure to combat climate change. Evidence base	Research, policy and delivery relevant to green infrastructure and climate change	Mainly UK, with several examples from Europe.	The evidence base holds a review of key documents relevant to the climate change mitigation and adaptation roles of green infrastructure. The database includes over 170 entries and is searchable by evidence type, organisation, data range, level of document, geographical area and keywords. Each entry includes a description and key messages.
Canada Mortgage and Housing Association www.commons.bcit.ca/greenroof/publications/resource_manual.pdf	Green roofs. A resource manual for municipal policy makers	Green roofs.	International, mainly Canada, USA and Europe	The pdf document includes 12 case studies chosen based on the maturity of the green roof policies and programmes, and their success. Descriptions are detailed and include information on process and lessons learned.
Green Roofs for Healthy Cities http://greenroofs.org/grtok/	Green roofs tree of knowledge	Green roofs	International	This database is composed of detailed summaries of research and policy papers in English from around the world. The database is searchable by the following categories: economic benefits, materials and plant research, policy initiatives, social and bio-physical initiatives. The database is open, e.g. users can add their own examples.
Assembly of European Regions http://www.aer.eu/main-issues/environment/best-practices-on-climate-change.html	Best regional strategies on Climate Change mitigation and adaptation	Regional strategies on adaptation and mitigation	Europe	The database includes 12 examples of regional strategies. A call for contribution has been issued to European regions.
National Oceanic and Atmospheric Administration, USA http://community.csc.noaa.gov/climateadaptation/index.php?option=com_docman&task=cat_view&gid=45&Itemid=32	Adaptation / Action Plans	Climate change adaptation action plans produced by cities	Mainly USA and Canada, some international examples	The database includes links to pdf versions of around 40 adaptation action plans produced by different cities.
Three Regions Climate Change Group, UK http://www.london.gov.uk/trccg/publications/	Adapting to climate change: a case study companion to the checklist for development	Built environment case studies that incorporate climate change adaptation in their design and construction.	Mainly UK, some international examples	This document provides guidance to assist developers and their design teams in incorporating techniques that minimise, at the design stage of development, the risks associated with the changing climate. The case studies are organised under the headings: location, site layout, buildings, ventilation & cooling, drainage, water, outdoor spaces and connectivity. Each case study provides key adaptation responses to climate change and points to note.
Town and Country Planning Association, UK http://www.tcpa.org.uk/pages/climate-change-adaptation-by-design.html	Climate change adaptation by design	Adaptation strategies at different spatial scales; advice on how to carry out adaptation actions	International	This document focuses on how to implement adaptation through design and development, including problems relating to high temperatures, flood risks, water resources and ground conditions. The adaptation measures are not limited to those involving green and blue spaces.

Author or host URL	Title	Thematic scope	Geographical scope	Details
The National Association of Industrial and Office Properties Research Foundation www.naiop.org/foundation/greenincentives.pdf	Green Building Incentives That Work: A look at how local governments are incentivising green development.	Incentives for developers for sustainable solutions in buildings	US	Examples of incentives used by local governments in the US to encourage developers to include green solutions in their designs. The list of local governments is categorised according to the type of incentive offered. In addition, the report presents results of a survey on the subject of incentives carried out with developers, architects and municipal government officials.