

Adapting urban water infrastructures to face the effects of climate change - from strategy to technical implementation

Adaptation des infrastructures d'assainissement face aux effets du changement climatique – de la stratégie à la mise en œuvre technique

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RÉSUMÉ

Les structures et le cadre de vie en milieu urbain sont particulièrement vulnérables aux conséquences du changement climatique. L'effet d'îlot de chaleur ou une augmentation des crues soudaines peuvent créer des dommages importants en milieu urbain. Mais le bon fonctionnement des zones urbaines est l'une des principales conditions préalables à un développement économique durable. Les impacts du changement climatique peuvent conduire à une escalade des coûts des mesures d'adaptation. Les mesures d'adaptation efficaces et à moindres coûts ne sont guère disponibles.

Les agences de l'eau allemandes Lippeverband et Emschergenossenschaft ont uni leurs forces avec différents partenaires européens pour effectuer le projet "Future Cities – urban networks to face climate change", soutenu par la Communauté Européenne à travers le programme INTERREG IVB. Le projet vise à rendre les zones urbaines du nord-ouest de l'Europe aptes à faire face aux impacts prévus du changement climatique et d'engager une transformation proactive des structures urbaines face aux changements climatiques. Trois éléments clés stratégiques sont combinés afin de gagner des effets supplémentaires comme mesures d'adaptation: «structures vertes», «systèmes d'eau», «énergie». En particulier, la contribution des réseaux d'eau et des espaces verts peut augmenter la capacité d'adaptation et de résilience des zones urbaines face aux inondations.

ABSTRACT

City structures and the urban living environment are especially vulnerable to the consequences of climate change. The heat island effect or increased flash-flooding can create high damages in the urban environment. At the same time well functioning city regions are one of the most important pre-requisites for sustainable economic development. A mere reaction on the impacts of climate change will lead to a cost escalation for adaptive measures. Viable and cost-effective adaptation measures are only scarcely at hand.

The German water boards Lippeverband and Emschergenossenschaft have joined forces with different partner's through-out Europe to strive for "Future Cities – urban networks to face climate change", a network which is supported by the European funding programme INTERREG IVB. The project aims at making city regions in North-West Europe fit to cope with the predicted climate change impacts and to initiate the pro-active transformation of urban structures to face climate change. Three strategic urban key components - "green structures", "water systems" and "energy" – are combined for adaptation measures to gain surplus effects. Especially the contribution of water systems and green structures can increase the adaptive capacity and flood resilience of urban city regions.

KEYWORDS

Climate change, adaptation, urban city regions, urban network, INTERREG IVB

1 INTRODUCTION

Climate change is not a topic to be discussed in the far future – it is more and more on the agenda of actual scientific, political and public discussions. Heat island effects in summer or wetter winters with increased flash flooding are actual phenomena which have great impacts on the urban living conditions. Rising temperatures and weather extremes like floods and storms derogate the quality of life in our towns and cities. We have to face these challenges. Our urban city regions must react on the effects of climate change.

The European Commission published the White Paper “Adapting to climate change: Towards a European framework for action”, in April 2009. Herein, the European Commission states: “Climate change increases land and sea temperatures and alters precipitation quantity and patterns, resulting in the increase of global average sea level, risks of coastal erosion and an expected increase in the severity of weather-related natural disasters. Changing water levels, temperatures and flow will in turn affect food supply, health, industry, and transport and ecosystem integrity”.

City structures and the urban living environment are especially vulnerable to these consequences. The heat island effect or increased flash-flooding can create high damages in the urban environment. At the same time well functioning city regions are one of the most important pre-requisites for sustainable economic development. A mere reaction on the impacts of climate change will lead to a cost escalation for adaptive measures. Viable and cost-effective adaptation measures are only scarcely at hand.

Therefore, anticipatory strategies are needed for adapting the urban structures in a way that the impacts of a changing climate will not endanger the urban living environment.

2 PROJECT AIMS

On the national level as well as on the European level, a lot of urban networks exist to promote strategies to mitigate greenhouse gas emission. Mitigation is important, but not sufficient. It will be impossible to reduce the effects quickly enough to avoid dangerous or negative effects on people's life, economy and ecology. It is obvious that beside mitigation, especially adaptation is necessary. There is consensus here in theory but it is difficult to realise in practice. This calls for a coordinated action and for transnational cooperation.

Lippeverband and Emschergenossenschaft have joined forces with eight partners from five European countries to create a project entitled “**Future Cities – urban networks to face climate change**”. The project aims at making city regions in North-West Europe fit to cope with the predicted climate change impacts. The project partners have developed a strategy which combines selected strategic urban key components – green structures, water systems and energy efficiency – for a pro-active transformation of urban structures. (Figure 1)

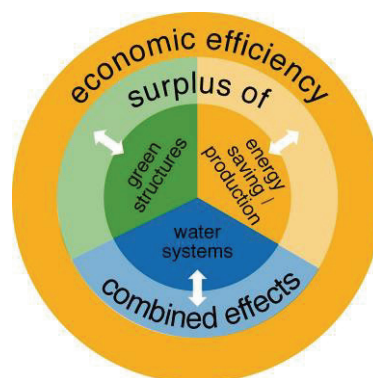


Figure 1 : Key components for the development of a pro-active transformation of urban structures.

From 2008 to 2012, two water boards, six municipalities, two regional planning associations and two project development agencies are cooperating to implement this strategy. The project budget is about 11 Mio. Euro of which is 50% funded by the European Union. The work comprises:

- Common evaluation methods for climate-adapted towns and cities – leading to an assessment check for climate-proof cities
- Action plans for current structures to enable the participating regions to adapt their strategies in a concrete manner
- Implementation of combined measures: Selected construction solutions in eight pilot projects
- Awareness raising of decision-makers and multipliers for pro-active ways of tackling adaptation to climate change impacts.

3 THE INTERNATIONAL PROJECT PARTNERSHIP OF FUTURE CITIES

The Future Cities partnership includes water boards, urban administrations, planning companies and project developers in North-West Europe. The geographical scope of the partnership covers densely populated areas in river catchments or directly at the coast: Northern Ruhr area with the catchments of the rivers Lippe and Emscher as tributaries of the Rhine, the province of Gelderland in the catchment of the rivers Nederrijn and Waal, the region Haute-Normandie in the catchment of the River Seine, West Flanders with the river catchment of the Lys and finally South-East England on the southern coastline of Great Britain. (Figure 2)

Each partner of the Future Cities project has special expertise in a field of necessary action: E.g. the expertise of water boards about the urban water system is combined with the expertise of the municipalities with regard to the effects of green structures. The involvement of regional planning authorities secures the expertise in planning guidelines as well as development agencies provide for know-how in planning with investors.



Figure 2 : The Future Cities-partnership covers city regions in Northwest Europe.

4 COMBINATION OF WATER SYSTEMS AND GREEN STRUCTURES

Taking the results of the fourth report of the Intergovernmental Panel for Climate Change (IPCC, 2007) it becomes clear quickly that the water sector is very much affected by the climate change: Possible impacts are e.g. increase of temperature up to 2,0°C (average-temperature), more days with higher temperature, less frost days, more precipitation in winter (monthly), less precipitation in summer (monthly), higher occurrence probability of storm water events, and increase of the groundwater level. On the other hand the water sector can contribute a lot to face and reduce the negative consequences of climate change. Being combined with green structures, challenges like flash floods and urban heat islands can be strongly addressed.

The Lippeverband and Emscher-genossenschaft are water boards being responsible for two river catchments in North Rhine-Westphalia. As they have long-time and high resolution rainfall data and

operating data available since more than 70 years, more knowledge exists about the regional climate development. One of the drawn conclusions from analysing the historical data is that at present there seems to be no need for rash action, as there are no statistically significant changes proofed. But: There remains a high uncertainty in the accuracy of the available climate projections. And: The extreme rainfall events which occurred in the last summers in various places over Europe strengthen the need for action.

Following the uncertainties, long-term and flexible strategies are needed with the possibility to adjust if necessary. One developed strategy seeks to compensate the effects of climate change by strengthening the natural water cycle. Disconnection of paved areas, decentralized retaining and infiltration of rainwater, adapted land use in agriculture and forestry, adapted urban and regional planning and rain water reuse are possible measures (Figure 3). These changes strengthen the natural water cycle, increase the adaptive capacity of the water management and therefore give time for more and better research. Besides these effects it can be used for attractive design of open space.



Figure 3 : Example for a disconnection measure of storm water.

The strategy can be summarized as “no regret strategy” as the measures serve also other objectives in the sense of sustainable development. And they are long-term, functional and cost-efficient adjustable.

This approach of the water boards has to be widened up. In order to address more direct and indirect impacts of climate change, not only the water systems can be taken into account, but the urban infrastructures as a whole. The Future Cities-partnership consists therefore of more partners from different sectors. The expertise of water boards about the urban water system is combined with the expertise of the municipalities with regard to the effects of green structures. The involvement of regional planning authorities secures the expertise in planning guidelines as well as development agencies provide for know-how in planning with investors. The Future Cities-strategy includes the sector know-how for the aim to pro-actively transform urban structures to cope with the effects of climate change in a holistic way.

The partnership focuses on two aspects: In the first place especially densely populated areas are involved. Here the consequences of climate change affect the living environment of people as well as economics and society in a special manner. The vulnerability of metropolitan regions is especially high. But at the same time the well-functioning of the cities is crucial for the economy of Europe. City regions can be regarded as “the economic powerhouse of Europe”. Therefore it is essential that urbanised areas are not harmed by climate change. Secondly the Future Cities project focuses on the existing infrastructure. For new developments a great knowledge is available how to build energy efficiently, preserving natural resources, and climate-proof. But for the existing infrastructure, old industrial sites, even older housing stock, no practical measures are at hand which do not cause immense costs. Here, especially cost-effective measures are needed.

5 EXEMPLARY TRANSFORMATION OF URBAN AREAS IN NORTH WEST EUROPE

In order to achieve the transformation of buildings and urban areas the ownership is of high importance. The Future Cities-partnership pursues three promising ways: The transformation of buildings in the ownership of the cities (at the exemplary site of Nijmegen in the Netherlands), converting major business areas which decreases the number of stake-holders involved compared to the area size (exemplary site in Rouen in France), and fostering the transformation process by financial incentives for private owners (at the example of Heerener Mühlbach in Kamen in Germany).

5.1 The green transformation of the city of Nijmegen

The Dutch city of Nijmegen plans to convert administration and business buildings with green roofs and green walls. Complementarily, exemplary public yard areas shall be transformed by implementing different types of green - grass, playing fields, shrubs- and blue spaces - infiltration fields, water squares. At the moment most public yards are mainly covered with impervious pavement and they are used as parking lot. Based on the idea book "Green Allure Inner City of Nijmegen" (Gemeente Nijmegen, 2007) feasibility studies will give definite answers concerning financial and technical possibilities. Together with stakeholders, projects are then implemented and monitored. Special focus is laid on public water art works to visualise water in the city for more awareness. Before, during and after the implementation the different effects of the transition on climate themes as water storage, water quality, energy savings or temperature rising will be monitored.

5.2 The sustainable urban site Luciline, Rouen

In the French city of Rouen, the public developing agency Rouen Seine Aménagement, together with the municipality, is converting 800 hectares of former industrial and port sites (Figure 4). Changing the purpose of these sectors gives an exceptional opportunity to create a compact new mixed residential and commercial centre of attraction linked to the river. Environmental objectives such as energy efficiency and the natural management of rain water can be realised.



Figure 4 : Project site Luciline in the city of Rouen, France.

The development of the sustainable urban site "Luciline" is part of the restructuring process. The aim is to adapt the Luciline district to the increase of temperatures. For this purpose, issues of energy, water management and ecosystems are combined on the site:

- A heat network is installed which is supplied by the geothermal sources located nearby: Ground water, water from the River Seine, spring waters, rain water, and wastewater will be used.
- A natural rainwater management system will serve as zones for the development of ecosystems, and as storage areas for the infiltration of rainwater.
- A network of green corridors will allow for development of urban biodiversity.
- The combination of the water structure and the green corridors will refresh and improve the built environment.

Rouen Seine Aménagement undertakes research for the limitation of the ecological footprint of the district's development. An important aspect here is the use of the geothermal potential for the heating and the cooling of all buildings built on the site.

The development of the sustainable urban site "Luciline" by Rouen Seine Aménagement and the City of Rouen is a project within the global environmental initiative of the city. Future Cities permits not only this project but the whole process to learn and profit from the experiments and best-practice methods of the other European partners.

5.3 Green-blue climate corridor in the catchment of the river Lippe

One major challenge of climate change is the uncertainty: An exact forecast of the local impacts due to climate change is not possible. Waiting and doing nothing cannot be the answer. Therefore, the Lippeverband is taking on its responsibility for its region, the Lippe catchment with 3,280 km² and 1.4 Mio. inhabitants. In planning strategies and concrete measures, the Lippeverband reviews where adaptation to climate change is necessary and where mitigation of greenhouse gas emissions is possible.

Because future rainfall and temperature are not exactly known, measures must be developed which are cost-effective, flexible in the long-run and also serve other objectives in sustainable urban development - the so called "no-regret measures". The ecological transformation of the River Lippe and its tributaries is combined with the disconnection of storm water. This creates a green-blue corridor with positive impacts on the local city climate.

The water body of the Heerener Mühlbach, a tributary to the River Lippe, in the German city of Kamen should be a best-practice example for such a green-blue corridor. Financial incentives for private house owners shall support the realisation of the ecologically improvement over a length of 2.14 km. The rainwater run-off of about 80 houses with a paved area of 1.1 hectares will be disconnected from the wastewater system and the storm water will be drained into the new, nature-like water body. A green corridor will be built through the city of Kamen contributing to making the city climate-proof. The citizens will be made aware of what they can personally do to face climate change – such as disconnecting their private property. (Figure 5)



Figure 5 : Heerener Mühlbach will be transformed into a green-blue corridor to improve the micro-climate.

Three aspects of adaptation to climate change are addressed:

1. Reduction of flood risks: Floods in the River Lippe and its tributaries in case of heavy rainfalls have become more often as well as more extreme. The ecological improvement and the sustainable use of storm water can reduce these floods as the sewer system will not be burdened with the amount of storm water that will be disconnected.
2. Reduction of heat-island-effect in summer: In summer the water bodies tend to dry out more as the temperatures are rising. With the use of rain water for the open water body the water cycle will remain sound even in dry periods and evaporation creates a better micro climate.
3. Strengthening the ecological system: The ecological functions of the water system will be enhanced. The additional retention area and green structures will contribute to cooling, evapotranspiration and fresh air in the urban environment.

6 CONCLUSIONS AND OUTLOOK

The Future Cities-partnership has started with designing and implementing the pilot measures throughout North-West Europe. The start of the measures is promising. Using no-regret measures and combining especially the key components water systems and green structures offers a broad range of cost-effective and socially accepted measures which help urban regions to adapt to impacts of the changing climate. In this way they complement the existing concepts to respond to the impending natural hazards in Europe, e.g. by supporting an effective flood risk management (EU directive flood risks, 2007; Haupter et al., 2007).

Beyond implementing structural measures, the realisation of a comprehensive integrated transformation of cities calls for accompanying “soft” measures. An overall framework for all actions is needed. Here, the Future Cities-partnership develops an “Assessment check for climate proof cities” which ensures coordinated and effective actions by different stakeholders and responsible organisations, e.g. to avoid counterproductive measures and to ensure the optimisation of adaptation measures with view to mitigation of greenhouse gas emission as well as sustainability aspects. The methodology developed will support decisions on how to make the urban infrastructures climate-proof with cost-effective measures. The assessment check itself is targeted at planners at cities and water boards, the results have to be used by those responsible for implementing measures. International exchange on the results of the pilot actions will improve measures and provide transferable solutions for other countries. The effectiveness of the measures is monitored and evaluated for further development of the assessment check for climate proof cities.

Addressing strategic stakeholders and disseminators is important for triggering a more pro-active approach on a wide scale. The aim is to raise the awareness for the necessity and the chances of adaptation to climate change.

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Information about actual project results is available at www.future-cities.eu

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