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How to Successfully Achieve Urban Adaptation Using Green and Blue Infrastructure?

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I. BROADER CONTEXT AND OBJECTIVE

The number of people living in cities has increased rapidly in the last decades due to a rapid population growth and, most importantly, increasing rates of urbanisation. Compared to 1950, when the urbanisation was 30%, it was 54% globally in 2014, and a full 73% in Europe. In total, this translates to approximately 3.9 billion people worldwide living in urbanised environment and it is expected to grow further (UN 2014).

The ongoing climate change brings along phenomena that may have an impact primarily on city inhabitants in the future, for example through water deficiency, (flash) floods, heat waves or drought. It is therefore necessary that cities react to these new conditions and use adaptive measures to help their inhabitants to adapt to climate change.

In order to tackle the impacts of global climate change, the EU has published the EU Strategy on Adaptation to Climate Change, which led to the establishment of national strategies. However, strategies do not bring solutions by themselves.

At the city level, there are often implemented ad-hoc single-purpose adaptive measures, that can be characterized as grey infrastructure (e.g., mobile flood barriers). Blue and green infrastructure is becoming more popular in many cities as an alternative solution to adaptation to climate change. These nature-based measures generate a number of co-benefits for society, which should be taken into account while making a decision about implementation of specific adaptive measures into a broader framework of environmental governance.

From our point of view, adaptation has to be perceived as a process that involves identification of suitable measures and their location in an area, economic assessment, institutional and/or stakeholder analysis handling conflicts among actors, and setting of institutions for potential implementation of the measures. These aspects then have to be included in urban strategies and, through them, in land use plans.

However, quantitative methods (economic valuation) in socio-economic environmental research still dominate as the main methodological approach used for decision-making in environmental governance. According to Downward et Mearman (2006), Bryman (2006), Austin et al. (2010) and others, a combination of quantitative and qualitative research could contribute to environmental management more effectively.

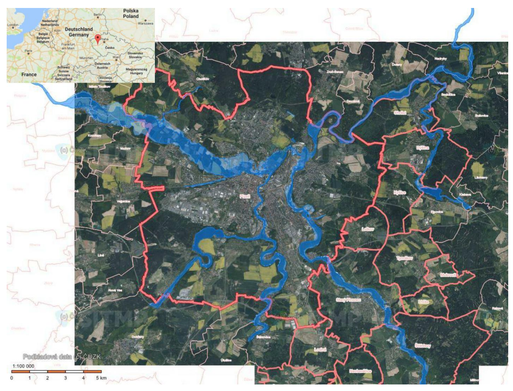
The goal of this research is to discuss the importance of combinations of outputs obtained from both quantitative and qualitative research for successful implementation of urban adaptation measures.

II. STUDY AREA AND METHODS

A successful adaptation process can be demonstrated on an example of the city of Pilsen (Czech Republic). Pilsen is situated in the western part of the Czech Republic. Four smaller rivers flow through the city and form the Berounka river. (Flash) floods are one of the most serious threats to the city in relation to climate change. With average rainfall of 533 mm/year Pilsen has recently faced the problem of insufficient rain water absorption.

The analysis of our research is based on a combination of quantitative and qualitative approaches. To evaluate some of the possible adaption measures in economic terms, we used modified cost-benefit analysis - results are in annualized value. Qualitative approach is represented by institutional and stakeholder analysis.

As a specific example of the CBA, measures that had previously been implemented in Pilsen were selected – Parking lot with permeable surface and Urban wetlands Lobezská jezírka.



Source: https://gis.plzen.eu

Urban wetlands in Pilsen

Photo: Eva Brejchová © 2015

- Wetland biotope complemented by a park
- Previously uncared-for green space, finished in 2015
- 4 lagoons retain 7,500 – 8,300 m^3 of water
- Sports-recreational elements, educational function
- Area of 3.5 hectars

Parking lot with permeable surface Pilsen

Photo: Eva Brejchová © 2015

- 33 parking spaces , finished in 2012
- Part of a sports centre Relax park
- Unilateral slope of a roadway with draining water into in-depth infiltration dry well made of gravel brash in the surrounding terrain
- Concrete semi-vegetative blocks
- Area of 934m^2

III. INSTITUTIONAL AND STAKEHOLDER ANALYSIS

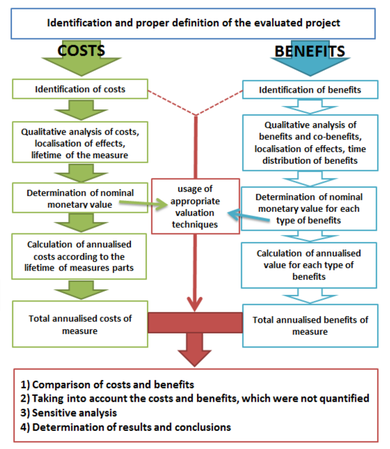
The analysis was carried out using in-depth interviews of representatives of various stakeholders (political representatives of the city, officials, private companies, non-governmental non-profit organizations, public property governors). In the analysis, we pay more attention to attitudes, opinions and expectations of various key actors with respect to particular possible adaptive measures, which deal with the problem of insufficient water absorption. Main goal was to analyse efficiency and feasibility of measures, which would reduce rainwater runoff and also to analyse connections between level of support that ecosystem measures get and influence necessary for actual implementation.

IV. COST-BENEFIT ANALYSIS

The costs are set according to project budgets and estimated operating costs. The identification of benefits is based on the ecosystem services approach. Besides ecosystem services divided into 4 groups (supporting, provisioning, regulating and cultural services), other benefits other benefits such as biodiversity (habitat creation) were also taken into account. The following table shows qualitative assessment of the benefits. The benefits valuated in monetary units are marked with a dollar symbol.

	Reducing water volume at WWTP	Lowering risk of flooding	Supplying surface water and groundwater	Improving water quality	Regulation of micro-climate /city's heat island	Noise reduction	Energy savings	Air quality improvement	CO2 reduction	Erosion reduction	Real estate value	Recreational benefits	Increase in aesthetic value	Biomass production	Crop production (urban agriculture)	Habitat creation	construction costs reduction
Wetlands	$	$	$	$				$		$		$	$			$	
Parking lot	$																$

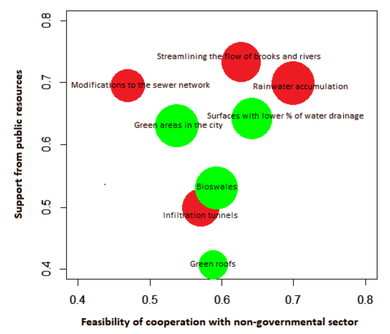
Legend: Full provision | Limited provision | Not provided | $ Benefits valuated in monetary units



V. RESULT

Overall potential of individual adaptive measures consists of three aspects: i) measure's effectivity, ii) feasibility of public financing of the measure, which is directly related to political support to a specific kind of investment, iii) feasibility of cooperation with non-governmental sector in terms of co-financing, eventually self-financing.

The picture on the right side visualizes the average rating of individual measures by all involved sides. The axes represent political support (willingness to finance the measures from public resources) and feasibility of implementation in cooperation with non-governmental organizations [0 – no potential in given criterion, 1 – potential of given criterion is fully exhausted]. Size of a circle represents an ability of given measure to achieve the goal of improving management of rainwater and ability to deal with the problem of floods. Ecosystem-based measures are represented by green circles, technically oriented measures are red. The large circles located in the top-right corner are the ones with the highest potential according to the respondents.



The analysis showed that the NGOs are proponents of eco-system based measures. Experience from other cities shows that ability of non-profit sector in a given city to implement pilot measures independently of the public administration is a crucial step that leads to higher awareness and later to better acceptability of innovative solutions.

The comparison of costs and benefits of both types of the measures shows that the total social benefits exceed the costs of the measure implementation and operating costs. From a purely economic point of view, the implementation of the urban wetlands and of the parking lot with permeable surface makes sense. The monetary value of the benefits does not include all provided ecosystem services and benefits; the total benefits would be greater in such case.

C B	Yearly (annualised) costs (EUR)	Yearly (annualised) benefits (EUR)	Benefits-costs ratio
Wetlands	59,484	1,529,293	25.7
Parking lot with permeable surface	729	1,754	2.4

CONCLUSIONS

The results of the quantitative analysis show that the implementation of both the urban wetlands and the parking lot with permeable surface brings net social benefits. On the other hand, the results of the qualitative analysis show that stakeholders are willing to pay only for some of the measures using public resources, regardless of whether they are technical or nature-base solutions. It seems that the strength of the non-profit sector is vital for implementation of the ecosystem-based measures, which can play a great role in acceptability of these solutions by public.

The mixed-method research introduced in the analysis explores a new way of combining quantitative and qualitative methods, which is considered to be a useful practice for reaching better environmental governance. According to our understanding, the goal of the qualitative institutional analysis is not to verify the adequacy of the cost-benefit analysis, but rather to better address cultural and social perspectives of society representatives and to reveal institutional failures that lead to the mismanagement of adaptation measures in cities. Such knowledge helps to create acceptable and robust environmental policy with better prioritization of the management goals supported by the quantitative. For decision makers, quantification of social values may also often represent the crucial argument for action – what action to pursue depends on the outcome of the institutional analysis. In our view, one method is not supplementary to another, but they represent full and equal complements in terms of the ultimate results.

Literature (selected)

[1] AUSTIN, Z., et al. 2010. Identifying conflicts and opportunities for collaboration in the management of a wildlife resource: a mixed-methods approach. *Wildlife Research* 37(8), 647-657

[2] BRYMAN, A. 2006. Integrating quantitative and qualitative research: how is it done? *Qualitative Research* 6(1), 97-113

[3] DOWNWARD, P., MEARMAN, A. 2006. Retroduction as mixed-methods triangulation in economic research: reorienting economics into social science. *Cambridge Journal of Economics* 31(1), pp. 77-99

[4] UNITED NATIONS. 2014. *World Urbanization Prospects: The 2014 Revision*, Highlights (ST/ESA/SER.A/352), [Online]. Available: http://esa.un.org/unpd/wup/highlights/wup2014-highlights.pdf

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