Flood risk mitigation and urban development - formulation and demonstration of integrated approaches

Réduction des risques d'inondation et développement urbain - la formulation et démonstration d'approches intégrées

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RÉSUMÉ

La fréquence accrue de fortes précipitations entraîne des inondations des zones urbaines, ce qui provoque des dégâts considérables et occasionne donc des frais importants dans la zone urbaine et même, dans certains cas, des blessures corporelles. Le réseau souterrain des égouts n'est pas adapté pour faire face à des précipitations très intenses. L'agrandissement et l'amélioration du réseau des égouts et la construction – en général souterraine – de bassins de rétention des eaux pluviales ne peuvent suffire à résoudre efficacement le problème. Par conséquent, les autorités responsables de l'assainissement et de la planification urbaine ont une responsabilité conjointe et doivent reconnaître que le ruissellement de surface est une force structurelle et optimiser l'organisation spatiale de la ville dans l'interaction entre la topographie, les trajets de flux de surface et souterrains, et des programmes d'utilisation de l'espace adaptés à ces flux. Le but est de développer de nouvelles formes de collaboration et d'établir des processus de planification intégrée tenant compte des besoins de la « conception urbaine sensible à l'eau ». Cet article présente une méthodologie qui coordonne et justifie la mise en relation de la réduction des risques d'inondation et du développement urbain pour élaborer des conceptions intégrées de gestion des eaux pluviales. Ces lignes d'action sont élaborées dans le cadre d'un projet de recherche intitulé « La ville en tant que système hydrologique au fil du changement. Mesures en vue d'un système de gestion adaptable des ressources d'eau en milieu urbain » (SAMUWA), dans le sous-projet intitulé « Développement urbain et stratégies de planification des espaces ouverts ».

ABSTRACT

The increased frequency of heavy rainfall events lead to urban flooding which induces immense damage and thus results in substantial costs in the urban area and in some cases even bodily injuries. The underground sewage system cannot cope with extreme precipitation events. Enlargement and remediation of sewage systems and the construction of - generally underground - storm water retention basins alone cannot solve the problem efficiently. Consequently, urban drainage and urban planning authorities have a joint responsibility for recognizing surface run-off as a structurally-formative force and for optimizing the spatial organization of the city in the interplay between topography, surface and underground flow paths, and area utilization schemes adapted to the latter. The goal is to develop new forms of collaboration and to establish integrated planning processes bearing the needs of "water-sensitive urban design" in mind. The paper presents a methodology that coordinates and substantiates the interlinking of flood risk mitigation and urban development to devise integrated concepts for stormwater management. These guidelines for action are being elaborated as part of a research project entitled "The city as a hydrological system in the course of change. Steps towards an adaptable management system for urban water resources" (SAMUWA), in the sub-project entitled "Urban development and open space planning strategies".

KEYWORDS

Urban flooding, risk analysis, mitigation, water sensitive urban design, integrated storm water management

1 STATUS QUO AND BACKGROUND

Nowadays, the relationship between water resources management and urban development bodies is still characterized by a low degree of understanding of the interrelationships between water infrastructure systems, urban spaces and receiving waters (Brown, 2007; Picon, 2005).

Based on the historically developed ideal of “clean urbanism” (De Meulde and Shannon, 2008), the design of urban spaces is aimed at discharging storm water as rapidly as possible into the underground storm water and combined sewer system. It is necessary to awaken a new appreciation of the interrelationships between water infrastructure systems, urban spaces and receiving waters. The aim is to optimize the spatial organization of the city in the interplay between topography, surface and underground flow paths, and land use schemes. The basis for a coordinated course of action is the coordinated interchange of information and data between the various technical planners and public agencies (DWA, 2008). The combination of underground and surface flood prevention measures with urban development projects being planned creates synergy options aimed at the multifunctional design of urban spaces. This enables urban development value added to be generated, while simultaneously permitting improvements in climate comfort (Hoyer et al., 2011; Stokman et al., 2015).

2 INTERDISCIPLINARY FLOOD RISK MITIGATION AS A MUNICIPAL COMMUNITY TASK - DEVELOPMENT OF GUIDELINES FOR ACTION

The development of guidelines for action at the interface between water resources management and urban planning is the goal of the BMBF-sponsored research project entitled “The city as a hydrological system in the course of change. Steps towards an adaptable management system for urban water resources” (SAMUWA). In the case study of Wuppertal-Varresbeck (Germany), a gradual methodology (five-steps) is developed that harnesses flood prevention as an impulse for the development and design of urban spaces with a high quality of life.

2.1 Step 1: Definition of the spatial frame of reference and understanding the water system in the urban context

To understand the water system in its urban context, a key question that poses itself is that of the spatial scope of the study: urban planners are used to thinking in terms of municipal administrative boundaries, but the latter are not oriented towards water catchment area boundaries and the corresponding flow paths of the water. By this means, an integral, multi-dimensional frame of reference is created that has “water-sensitive urban development” as its purpose.

2.2 Step 2: Risk analysis – urban flooding

In a multi-step analytical procedure, it is examined whether there are risky areas in the municipality, highly vulnerable to being flooded, and if so where and to what extent (see Fig. 1). The basis is ideally a municipality-wide risk assessment (Gatke et al., 2015). These areas can be subsequently examined, simulated and assessed at greater depth by means of various local detailed topographical and hydrological analyses (flow paths), e.g. also using an interlinked 1D-2D sewer system-surface runoff model. The simulation shows what paths the rainwater takes during a rain event and the spatial spread of the water. By subsequently superimposing the existing area and building utilization and infrastructural facility plans on these vulnerable zones, the possible impact of floods, and consequently the damage and risk potential, can be ascertained.

2.3 Step 3: Development of a water-related urban planning model

A water-related model, viewed from an urban planning perspective, is developed on the basis of the risk assessment (step 2). The overall urban development plans and existing development scenarios provide the groundwork for this. Existing development trends are followed up and viewed in greater depth, thus allowing the potential and challenges associated with urban planning and the design of open spaces to be utilized optimally in combination with flood risk mitigation and rainwater management (see Fig. 1 and 2).

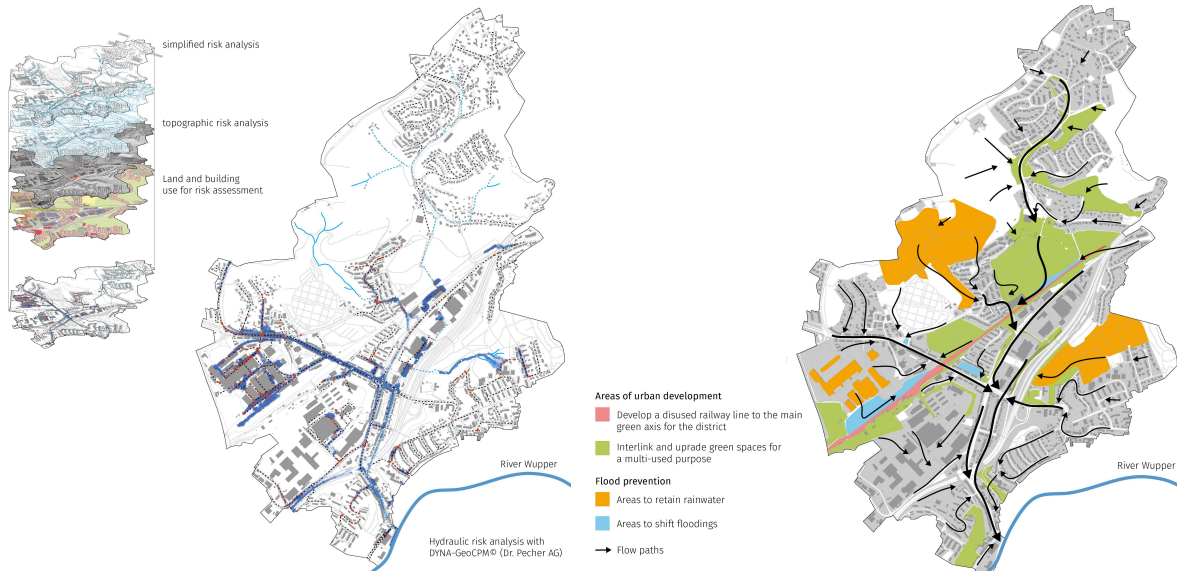

Fig. 1: Risk analysis of the project area (left) and map of a water-related urban development model for the project area (Dr. Pecher AG/ Institute of Landscape Design and Ecology, Stuttgart)

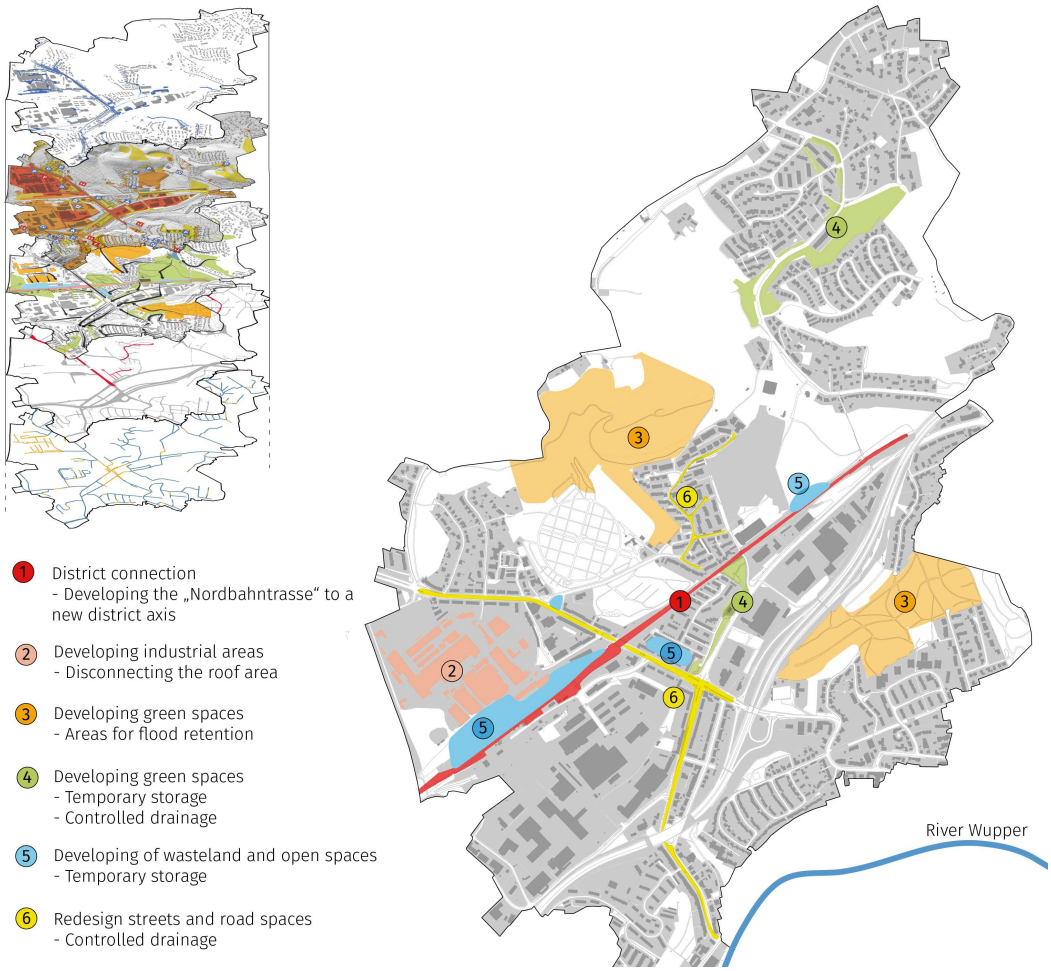

Fig. 2: The process of superimposing the maps containing the results of steps 2 and 3 and the focus areas thus ensuing

2.4 Step 4: Establishment and prioritization of focus areas

In a subsequent step, sanitary water engineering and urban planning aspects are very closely interlinked with one another: the water-related urban development model (Step 3) is superimposed on the areas highly vulnerable to flooding (Step 2). In addition, further items of information and aspects, such as any hydraulic remediation of the sewage system needed, traffic projects and the urban climate, are also included in the analysis.

The aim is to identify focus areas by revealing any possible links between the necessity for flood prevention measures and strategic urban development projects or measures capable of being executed in the short term as part of ongoing projects and also measures being taken by other development authorities (see Fig. 2).

2.5 Step 5: Development of integrated action and design-related concepts

For the focus areas and spheres identified, water resources management and urban design measures are subsequently developed and put into concrete form.

3 CONCLUSIONS

The strategies to which attention has been drawn are designed to use flood risk mitigation as an impulse for the development and design of urban spaces with a high quality of life and to encourage interdisciplinary and cross-departmental collaboration by coordinating analytical steps with one another and highlighting interfaces between the disciplines of water resources management and municipal planning. Bearing this in mind, the need to develop new, low-cost and efficient solutions to the increasing problems involving flooding open up an opportunity for once again elevating the surface flow paths of the water and the landscape's geomorphological structure to the importance of a fundamental regulative factor of the cityscape.

Such a water-sensitive urban development approach can create new topographical characteristics of areas and open spaces and link these with one another. This could foster sustainable urban development and significantly increase the quality of life and leisure in our cities.

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