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Multifunctional areas, one of the solutions for Hamburg (Germany) on the way towards a water sensitive city

Espaces multifonctionnels, une solution vers une ville durable pour Hamburg (Allemagne)

Pascale Rouault, Julia Doering, Andreas Baier, Franziska Meinzingler

Hamburg Wasser, Billhorner Deich 2, 20539 Hamburg,
pascale.rouault@hamburgwasser.de, julia-doering@hamburgwasser.de,
andreas.baier@hamburgwasser.de, franziska.meinzingler@hamburgwasser.de

RÉSUMÉ

En raison du changement climatique, il faut s'attendre à l'avenir à des phénomènes météorologiques extrêmes plus fréquents dans la ville de Hamburg. Selon les prévisions actuelles, les événements de fortes précipitations, en particulier, augmenteront en fréquence et en intensité. Cela devrait également s'accompagner d'une augmentation des inondations et des dommages associés aux bâtiments et aux infrastructures. L'imperméabilisation croissante signifie que moins d'eau percole et que les processus d'évaporation sont fortement limités par une verdure urbaine clairsemée. Le ruissellement de surface domine dans les quartiers très denses, avec des conséquences négatives pour l'écologie aquatique, la recharge des nappes phréatiques et le climat urbain. Dans ce contexte, la conception et l'utilisation ciblées d'espaces ouverts urbains en tant que zones de rétention temporaire - appelées zones de rétention multifonctionnelles - représentent une composante importante pour la prévention des inondations et de l'adaptation au changement climatique au niveau municipal. Afin d'identifier les potentiels de prévention des fortes pluies, une méthodologie d'analyse du potentiel des zones multifonctionnelles a été développée et appliquée à l'aide d'un examen automatisé basé sur le SIG. Des projets pilotes ont été mis en œuvre avec un retour d'expérience très positif. Trois d'entre eux sont brièvement présentés dans ce document.

ABSTRACT

Due to climate change, more frequent weather extremes must be expected in the city of Hamburg in the future. According to current forecasts, heavy rainfall events in particular will increase in frequency and intensity. This is also expected to be accompanied by an increase in flooding and the associated damage to buildings and infrastructure. Increasing sealing means that less water percolates and evaporation processes are severely restricted by sparse urban greenery. Surface runoff dominates in highly dense neighborhoods, with negative consequences for aquatic ecology, groundwater recharge, and the urban climate. In this context, the targeted design and use of urban open spaces as temporary retention areas - so-called multifunctional retention areas - represents an important component of municipal flood prevention and climate change adaptation. In order to identify potentials for heavy rainfall prevention a methodology for a potential analysis of multifunctional areas has been developed and applied using an automated, GIS-based screening. Pilot projects have been implemented with a very positive return of experience. Three of them are briefly presented in this paper.

KEYWORDS

blue-green infrastructure, flood prevention, multifunctional area, water sensitive city

1 MULTIFUNCTIONAL AREAS, ADVANTAGES UND CHALLENGES

1.1 Motivation for implementation of multifunctional areas

Due to climate change, more frequent weather extremes must be expected in the city of Hamburg in the future. According to current forecasts, heavy rainfall events in particular will increase in frequency and intensity. This is also expected to be accompanied by an increase in flooding and the associated damage to buildings and infrastructure.

Increasing sealing means that less water percolates and evaporation processes are severely restricted by sparse urban greenery. Surface runoff dominates in highly dense neighborhoods, with negative consequences for aquatic ecology, groundwater recharge, and the urban climate.

In this context, the targeted design and use of urban open spaces as temporary retention areas - so-called multifunctional retention areas - represents an important component of municipal flood prevention and climate change adaptation.

The principle of multifunctional areas for flood prevention provides that especially public open spaces, such as public squares, parking areas, green spaces or streets, are used temporarily and specifically as (emergency) storage space or as a drainage element, in addition to their actual main function, during rare heavy rains. They offer numerous advantages (Benden et al. 2017), such as the improvement of flood protection with minimal or no additional use of settlement area (solution of land use competition by combining land use claims), multiple use of existing or already planned infrastructure, low or minimal costs and bundling of financial resources, and have high synergy potential with other climate adaptation measures (e.g., for heat mitigation or improvement of air quality).

Following the first successful pilot projects on multifunctional land use in Hamburg (see chapter 2 as well as Krieger and Fröbe, 2014; Schleifenbaum et al., 2019), HAMBURG WASSER conducted a potential analysis on multifunctional areas using an automated, GIS-based screening in order to identify potentials for heavy rainfall prevention more broadly in the future and thus to be able to introduce them into planning processes in a targeted and early manner.

1.2 Methodology for identification of multifunctional areas

The identification of multifunctional areas begins with the determination of inundation hotspots, in which flood information data such as rainfall-induced operations by fire department, flow path depression analysis and sewer network simulations were used. The result map for Hamburg shows, after a largely automated process and with the selected specific prioritization parameters, about 50 flooding hotspots with high priority and about 220 flooding hotspots with medium priority. In addition, there are about 1,600 other flooding hotspots, but these are considered to have a lower flooding potential and thus are not prioritized in the development of measures.

The second step of this methodology consists in identifying potential multifunctional areas and to link them with flooding hotspots.

Following the method developed in the MURIEL project (Benden et al., 2017), potential multifunctional areas were selected based on administrative and functional characteristics. Public areas as well as land owned by the water utility HAMBURG WASSER are considered to be principally suitable from an administrative perspective. The selection from a functional perspective includes playgrounds, sports fields and neighborhood squares as well as open spaces, green areas and parks. However, objects or areas such as cemeteries, water bodies or buildings that exclude multifunctional use have been removed from the selected areas.

For the potential multifunctional areas with general administrative and/or functional suitability, the construction effort required to transform them was estimated and the availability was assessed by means of ownership. This helped in prioritising the general suitability of an area.

The next step in determining which potential multifunctional areas might actually be relevant after screening was to determine the distance to the heavy rainfall problem areas (flooding hotspots). Basically, all potential multifunctional areas that have at least one flooding focal point within 500 m are shown in the GIS map.

Within the 500 m search radius for potential multifunctional areas, a linkage could be established for almost every one of the approximately 270 flooding hotspots in focus. Not in each of these cases realization will be feasible, as not all factors - such as obstacles like railroad embankments or watercourses that prevent the design

of emergency waterways - could be considered in this automated GIS-based screening. Therefore, this map series should be viewed as an initial potential analysis that is not a substitute for detailed planning. It is intended to focus attention on potential areas that could be considered for multifunctional use for heavy rainfall prevention.

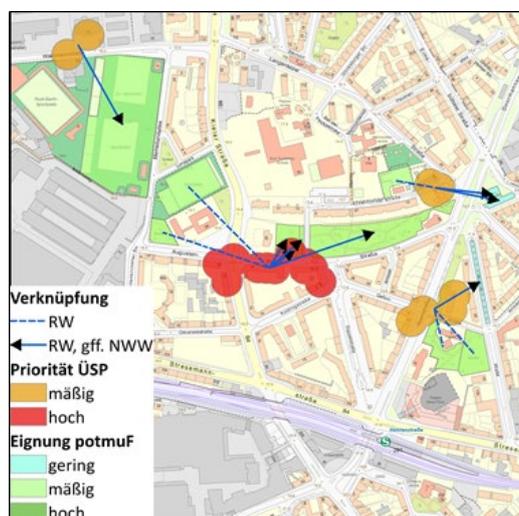


Figure 1: View of a part of the multifunctional potential analysis map for the city of Hamburg (legend in the map still to be translated)

2 EXAMPLES FOR IMPLEMENTATIONS OF MULTIFUNCTIONAL AREAS IN HAMBURG

In Hamburg, projects of multifunctional land use have already been implemented in the frame of the project RISA (RainInfraStructureAdaptation), which was started in 2009 by the Ministry of Urban Development and Environment (Behörde für Stadtentwicklung und Umwelt, BSU) together with the utility HAMBURG WASSER (HW) and represents an orientation framework for sustainable stormwater management in Hamburg. Thanks to this long-term cooperation pilots could be implemented and return of experience is now available for a brother implementation. In this chapter three projects are shortly described.

2.1 The sports facility « Möllner Landstrasse »

In the Hamburg district of Billstedt, flooding repeatedly occurred in the area of a low-lying street section during heavy rain events, causing basements to fill up. This not only caused damage to structures and property, but also endangered traffic safety in the area of the intersection and the operational safety of an adjacent subway station. The associated stormwater catchment area is characterized by multi-family residential development. Additionally, further densification of the catchment area is expected in connection with the residential development goals of the city of Hamburg. In the search for suitable solution for this issue, the sports field came into focus, which is topographically lower than the road and, due to its funnel-shaped grandstand enclosure, is virtually ideal as an occasional, multifunctional retention area for excess rainwater.

The storm sewer in the main street in front of the sports facility is relieved during heavy rain events by a DN 500 sewer extending approximately 30 cm above the invert. The offset of the relief sewer ensures that the unthreading only kicks in when the sewer is at a certain capacity (about twice a year). The so-called "first flush"³ therefore does not enter the relief channel. The hydrodynamic sewer network calculation of the rainwater catchment area has shown that approx. 700 m³ are thus discharged to the sports facility during a 10-year rain event. Based on a long-term simulation, a statistical return time of 2.3 times per year could be determined for rain events during which the stormwater is diverted to the sports field.

Two interconnected infiltration trenches were installed underneath the sports field for infiltration of excess stormwater (see figure 2). The infiltration trenches were designed as hollow-body infiltration trenches. In total, the connecting pipes and the two infiltration trenches result in a retention volume of 500 m³. Rainwater that exceeds this volume can be temporarily stored via the emergency overflows of the infiltration trenches on the surface in the area of the running track and the athletics area. Afterwards, the excess rainwater is infiltrated through the separate sports field drainage system or the infiltration trenches, in order to protect the

groundwater during underground infiltration as well as the infiltration ditches themselves from contamination, a pre-treatment of the rainwater was provided. Before the rainwater enters the infiltration trenches, coarse and floating material is retained in a settling tank.

Great importance was attached to the monitoring and maintenance of the elements of the spillway, as no experience has been gained with such facilities before, which are only fed infrequently and during more extreme events. The maintenance of the drainage installations is carried out by HAMBURG WASSER. Both the cleaning structure, the infiltration trenches and the discharge pipes are equipped with manholes and access points to allow visual inspection and cleaning. The access roads to the corresponding manholes will be designed for access by large equipment. As return of experience after three years of operation, this implementation is a success story, no important problems could be identified.

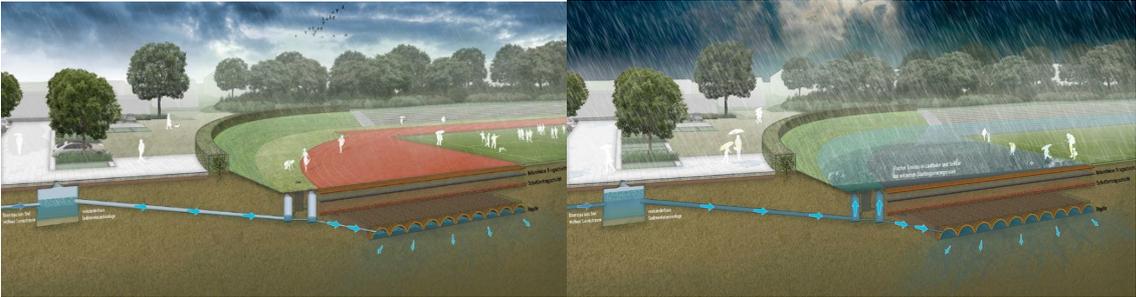


Figure 2: Design of multifunctional area sport facility « Möllner Landstrasse » (Source: Naumann Landscape architecture)

2.2 Stormwater Playground Hamburg Neugraben

A further example for a multifunctional area in Hamburg is the so-called « Stormwater Playground Neugraben ». Motivation for this project was a regular inundation of a nearby school yard due to a too small stormwater retention basin. There was no possibility for further extension of the retention basin. It was decided to use the playground area close to the school in case of heavy cloudbursts as a retention area.

The implementation of the multifunctional area was combined with a refurbishment of the playground. Therefore, a win-win-situation with respect to stormwater management as well as to social infrastructure was achieved. The retention of stormwater in the playground has already contributed several time to flood protection in the neighbourhood.



Figure 3 : pictures of the playground, left : before transformation into a stormwater playground ; middle : playground after transformation ; right : during rain event

2.3 Ohlendorffs Park

Motivation for this further project of multifunctional area in Hamburg was the frequent flooding of a street and underground parking in the past. The idea emerged to construct an emergency flow path for drainage from the street surface to a nearby public park. The project was implemented in 2016 and has proven to be a successful solution for flood prevention. Now the stormwater from the street is diverted to the park, is allowed to settle in a tank and can finally infiltrate in the park without causing damage.



Figure 4 : pictures of the Ohlendorffs Park, left : street before construction of discharge to the park ; middle : simulation of discharge effect for pre-planning ; right : effect of discharge during rain event

3 WHAT ABOUT A LARGER IMPLEMENTATION ?

All projects of multifunctional areas in Hamburg have in common that they are communal joint projects in which a positive and constructive cooperation across organizational and disciplinary boundaries was one of the greatest success factors.

Some of the lessons learned from the projects is that it is important to identify the ideal moment for innovation, to integrate issues and ideas of different partners, and to clarify responsibilities from the beginning.

Now, a process is currently being started to check the possible implementation of potentially useful multifunctional areas when integrating them into urban development processes using the potential analyses presented in chapter 1.

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