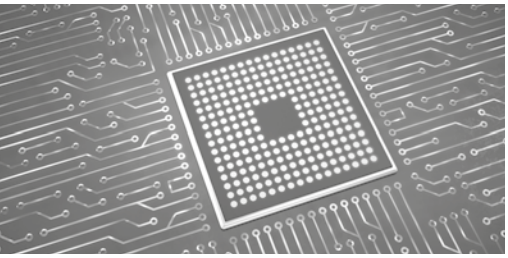
Urban Flash Floods

Drainage Planning
Flood Simulation
Hazard Analysis
Risk Assessment
Risk Management
Planning of Measures



Interdisciplinary
Solutions
From a Single Source

BJÖRNSEN CONSULTING ENGINEERS

Heavy Rainfall Events in Urban Areas

New Challenges for Municipal Flood Preparedness

In recent years, the number of heavy rainfall events has increased. Numerical modeling predicts an increased occurrence of heavy rainfall as a result of climate change. Since the sewer and property drainage systems of cities and communities often cannot cope with these water masses, the danger of urban flash floods increases as well.

Until recently, urban flash floods could not be pragmatically or efficiently handled using classic methods of municipal drainage. In recent years, however, new methods for municipal flood preparedness have been developed that emphasize hazard analysis and the mitigation of risks. These new methods have since become a core component of the applicable regulations, such as the DWA-M 119 guideline, which places the emphasis on the importance of municipal preparedness.

The interdisciplinary team at Björnsen Consulting Engineers provides you with tailor-made solutions for dealing with urban flash floods in all matters pertaining to urban drainage and risk management. We work closely with universities and research organizations and rapidly implement the latest findings and methods in our engineering practice.

Definition of Heavy Rain

Rainfall with large amounts of precipitation per unit of time.
Significant weather warning:
≥ 10 mm/1 hr. or ≥ 20 mm/6 hrs.
Severe weather warning:
≥ 25 mm/1 hr. or ≥ 35 mm/6 hrs.
(Source: dwd.de/lexikon)

Guidelines

DIN 19661	DIN 1986-100
DIN EN 752	DWA-A 117
DWA-A 118	DWA-M 103
DWA-M 119	EG-HWRM-RL

Tools of Drainage Planning

One-dimensional numerical modeling: Hydrodynamic sewer system calculations and street profile method

1

1 Sewer system calculations: flooded sewer network

Above what amount of precipitation and how often a sewer network will become flooded is determined by means of classic hydrodynamic sewer system calculations for unsteady non-uniform discharge processes by taking into consideration pressurized flow, backwater effect, and flow reversal.

Further results include the volume, intensity, and duration of the floodwaters above ground level. Flooded drains and floodplain areas can be localized in this way. An unusually heavy rainfall event that exceeds the sewer network capacity will drive the water to the surface.

How much rainfall can the sewer and street networks withstand?

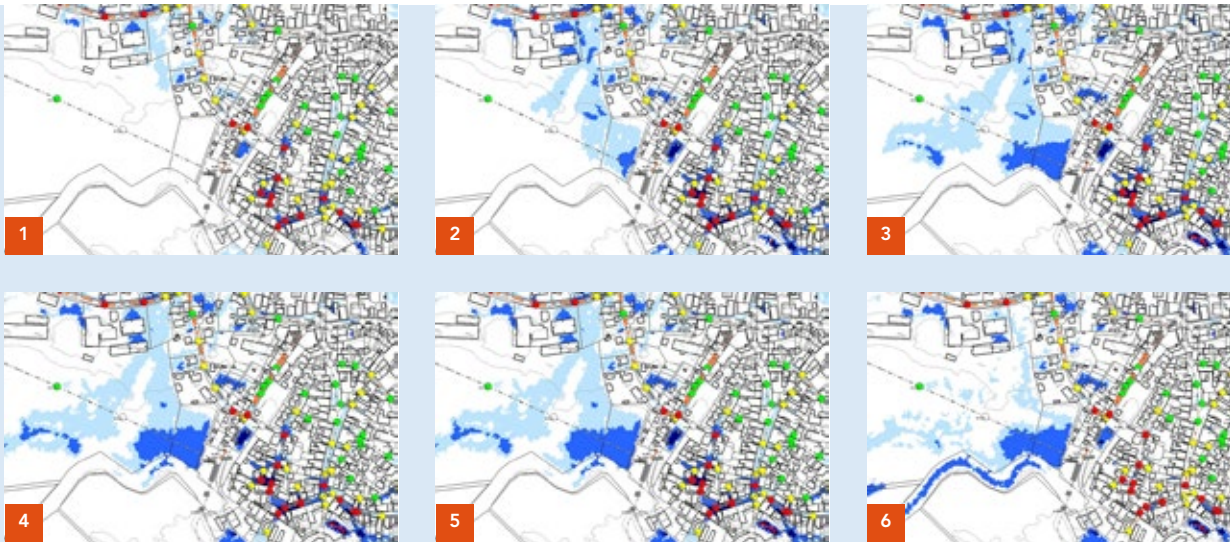
If the water is confined by curbs and remains primarily within the street, the street then functions as an emergency water channel. In an initial extended approach to consider surface flow paths together with the sewer system, the street profile method incorporates the street space as a flow conduit in the hydraulic analysis (1D/1D coupling).

Services

- Sewer cadastre
- In-situ measurements
- Model design and customization
- Model calibration and validation
- Visualization of results and analysis
- Hydraulic verification as per DWA-A 118 and DIN EN 752
- Pollution load calculations and verification as per DWA-A128
- Sewer condition survey and assessment as per DIN EN 13508-2/DWA-A 149-3
- Site development planning
- General drainage planning

Coupled Flood Simulation

1D/2D modeling of sewer network and surface – future-oriented analysis tool for urban flash floods



1–6 Coupled 1D/2D simulation with DYNA/GeoCPM (Tandler) in six time increments

If the 1D model of the sewer network is coupled with a 2D surface model, unconditional modeling of the bidirectional water exchange is possible, i.e. the water exchange between the sewer network and the municipal area is analyzed as a closed system. Hence the simulation also takes into account the flow of surface water back into the sewer system.

Full Coupling of Sewer and Surface Water

Coupled 1D/2D modeling is used where the area dispersal of floodwater is highly pronounced. Small-scale structures such as buildings, underpasses, curb edges, etc. are modeled in detail in order to understand their impact on flood distribution. Retention effects are also taken into consideration. This makes it possible to understand the hazard posed to the protected properties at various time increments.

Services

- Adoption and plausibility check of sewer network data and databases
- Processing of terrain data and urban models
- Site inspection and investigation
- Coupled 1D/2D modeling of the sewer network and surface runoff
- Visualization of results
- Flow path analysis

GIS-Supported Methods

Flow paths and static volume assessment

7 Result of a static volume assessment
8 Calculated flow paths and water depths

Does the water flow, and if yes, which paths does it take?

During unusually heavy rainfall events, the importance of the sewer network declines and the role of surface runoff increases. The same applies for slopes. In both cases, GIS-supported methods analyze the flood distribution and the flow paths.

Impounded areas can be calculated by intersecting the water volumes discharging from the sewer with the terrain morphology. Usage data (e.g. ALKIS data), surface roughness and precipitation data (e.g. KOSTRA Atlas or Radolon) are necessary to refine the analysis: the calculation results are flow paths, retention depths, and flow velocities. Buildings and elements of infrastructure (building areas, outlets, underpasses, railway embankments) are essential for the flow path calculation and need to be an integral part of the digital terrain model.

Simplified 2D calculation methods, such as disregard acceleration and turbulence terms, are used for calculating the flood distribution. These topography-informed methods are suitable not only for urban areas, but also for municipality areas without a sewer network, for sloped areas, and for small catchment areas in rural regions.

Services

- Preparation of geodata
- Static volume assessment
- Flow path calculation
- Visualization of results
- 3D presentation
- Video production

Hazard Analysis and Risk Assessment

Planning basis for sustainable and economic solutions

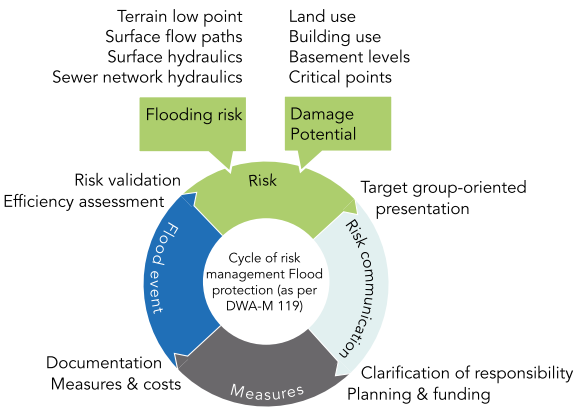
1 **Hot spots: zones impaired or blocked due to flooding**
2 **Critical Infrastructure Modeling**

Efficient problem-solving approaches can only be developed with knowledge of the hazards. Hazard analysis in urban areas focuses on determining affected objects and infrastructure by sectors, such as energy, IT and communication, transport and traffic, health, water, nourishment, and analyzes the way in which individual properties are exposed to hazard.

The risk assessment examines in detail the operational vulnerability and the monetary damage of the exposed objects. On the basis of the risk assessment of individual objects, conclusions can be drawn about the load on the urban system – for instance, if damage to critical infrastructure causes functional disruption to entire territorial units. The results are compiled in the GIS as spatial information. They are, among other things, the basis for assessments of economic viability, the planning of measures, and the alarm and emergency deployment planning.

Services

- Survey of individual property (e.g. basement, underground garage)
- Hazard and risk analysis
- Damage assessment, calculation of damage potential
- Hazard and risk mapping



Planning and Implementation of Measures

Municipal risk management and property protection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3 **Property protection for commerce**
4 **Plant protection for pumping stations**
5 **Sewer construction**

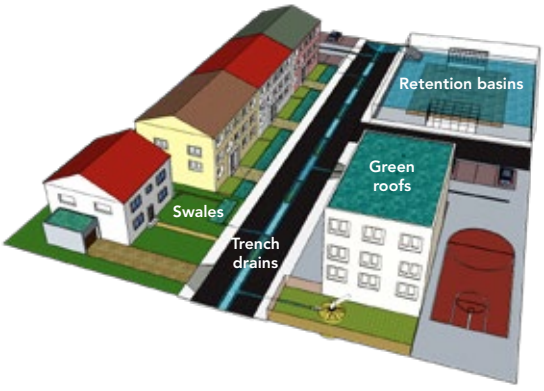
Flash floods are unavoidable, but damages can be limited.

We provide solutions for municipal risk management and the protection of individual properties for municipal drainage, urban planning, emergency management, and everyone at risk from urban flash floods. These include construction measures (general drainage planning, sewer rehabilitation, design of open spaces, flood control for equipment, safeguarding oil tanks), operational measures (changes of use, optimization of sewer system management) and organizational measures (alarm and emergency deployment plans).

We have been in the business of drainage planning for more than 50 years, working in interdisciplinary teams together with GIS experts, hydrologists, ecologists, and landscape architects. Our engineers design solutions for all spheres of activity – not only for bodies of water and sewer networks, but also for plants and buildings as well as their technical equipment.

Services

- Planning of measures
- Local stormwater management
- Property protection
- Structural engineering / Geotechnics
- Cost-benefit analysis
- Risk management
- Public relations



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