

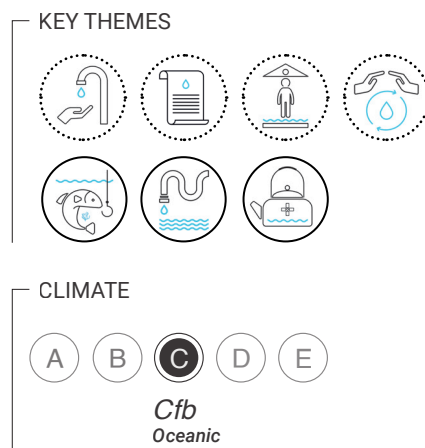




# Blue-Green Infrastructure: An Opportunity for New Natural Heritage in Zwolle

Nanco Dolman  
Deltares

*Living with water is an essential part of the cultural heritage of the city of Zwolle, NL. The historic development of the city within its water systems has been recognized as an inspiration for climate adaptation. In July 2019, the city of Zwolle presented its Adaptation Strategy. Building on its water heritage, a cohesive blue-green network (city scale) in the city can develop and expand, with room for urban sponges (neighborhood scale) that will combat heat stress. This will create a new natural heritage that is recognized and supported by the community. In this plan, various components are interconnected and will strengthen the blue-green network as the physical basis of an adaptation strategy to make Zwolle and its surroundings climate proof and adaptive. Zwolle's blue-green transformation aims at achieving SDG 11 "Sustainable Cities and Communities" and has the potential to fulfill targets regarding climate action (SDG13), the protection of water quality (SDG 6) and the restoration of biodiversity (SDG 14 and 15).*



< Fig. 1 Museum the "Fundatie" (foundation) along city canal in Zwolle's historic city center (Source: Nanco Dolman).

### **Dutch Demonstration Delta in Zwolle**

Zwolle is a mid-sized city in the IJssel-Vecht delta in the Netherlands, which has become a demonstration model of water resilience and climate adaptation. Efforts there align with the National Environmental Vision (NOVI) of the Zwolle Region for climate adaptive growth as designated by the Dutch Government. The IJssel-Vecht delta is a historic and vulnerable cultural landscape, with a unique delta ecology. It is close to Lake IJssel, dominated by several rivers interspersed with both low-lying wet polders and higher, dry catchment areas. In synergy with urban growth and climate change, the IJssel-Vecht delta adapts to water extremes, including floods and droughts.

Zwolle, which became one of the Dutch Hanseatic cities in the thirteenth century, marks the location in the IJssel-Vecht delta where the local and regional water system flows into the main water system. Water is a cornerstone of identity and mindset in Zwolle. Living with water, working together on water: these have always been taken for granted in Zwolle as necessary and important. In the synergy between its heritage and the current water issues, Zwolle has developed an adaptation strategy (Dolman 2019b) that proposes required activities and measures to transform Zwolle into a city with sufficient resilience to cope with climate change. By strengthening green infrastructure and giving water more room in both the public and private domain, Zwolle's ambition is to become the leading blue-green city of the Netherlands.

Although the definition may vary around the world, mid-sized cities have one thing in common: they represent the majority. Zwolle may well exemplify many mid-sized cities worldwide. The diversity of issues in Zwolle has sparked skills and solutions that could well be utilized

in other mid-sized cities. Zwolle's spatial transformation aims at achieving Sustainable Development Goal (SDG) 11 "Sustainable Cities and Communities" (Dolman 2021). The blue-green infrastructure (BGI) in Zwolle has the potential to fulfill multiple targets outlined in the SDGs, such as those related to water (SDG 6 and SDG 14), land (SDG 15) and climate change (SDG 13).

### **The Dutch Water City of Zwolle**

Zwolle was founded in the Middle Ages on a sand ridge between the IJssel river and the Overijsselse Vecht (Municipality of Zwolle 2019). This was an elevated and habitable place in an otherwise swampy landscape where the inhabitants of the city were protected against rising water. Due to the parallel location of the sand ridge along IJssel and Vecht, Zwolle originally had a linear shape. Until the middle of the sixteenth century, the low stream valleys around the city remained undisturbed. In 1294, Zwolle joined the Hanseatic League as a trading city. Since the city of Zwolle was only a few kilometers from the IJssel, to facilitate trade people wanted to dig a canal as early as the Middle Ages. This plan was successfully opposed for a long time by the competing IJssel towns of Kampen and Deventer. They managed to prevent the canal-building until 1819 when the Willemsvaart was opened, a canal which runs from the center of Zwolle to the river IJssel.

In the middle of the nineteenth century, the city walls lost their military function. For public health reasons following the 1866 cholera epidemic, the first sewer system was installed (in 1873). In 1900 railways began to influence Zwolle's spatial development. Workshops and working-class and residential areas were built in the immediate vicinity of the city center. And

to enable the expansion of the city and its traffic network, many natural stream valleys and waterways were filled in and “buried” under the urban expansions.

In the early 1960s, digging started on the Zwolle-IJssel Canal, which would connect the Zwarte Water with the river IJssel. This new canal was necessary to improve access to the new industrial area along the Zwarte Water after the expansion of the Holtenbroek district. In addition to shipping, the canal is also used for roach and bream fishing. Zander and eel are also caught with some regularity. Mussels are also found in the canal. After the Zwolle-IJssel Canal opened in 1964, the Willemsvaart became redundant. The old canal with the associated locks is now valued as heritage. The lock complex and the bridge keepers’ houses at the Katerveer can still be admired, as can the remaining part of the old canal. The locks near the river IJssel are still in the same condition as in 1819.

In November 2017, the city council adopted the environmental vision “My Zwolle of tomorrow,” a vision of the future that invites, inspires and stimulates citizens to fill in the space in the city together. The Environmental Vision for Zwolle indicates how the city can develop between now and 2030. The vision not only concerns growth and quality of life, but also sustainability, recreation, education, welfare, employment and efforts to deal with climate change.

### **Zwolle Adaptation Strategy Based on Water Heritage**

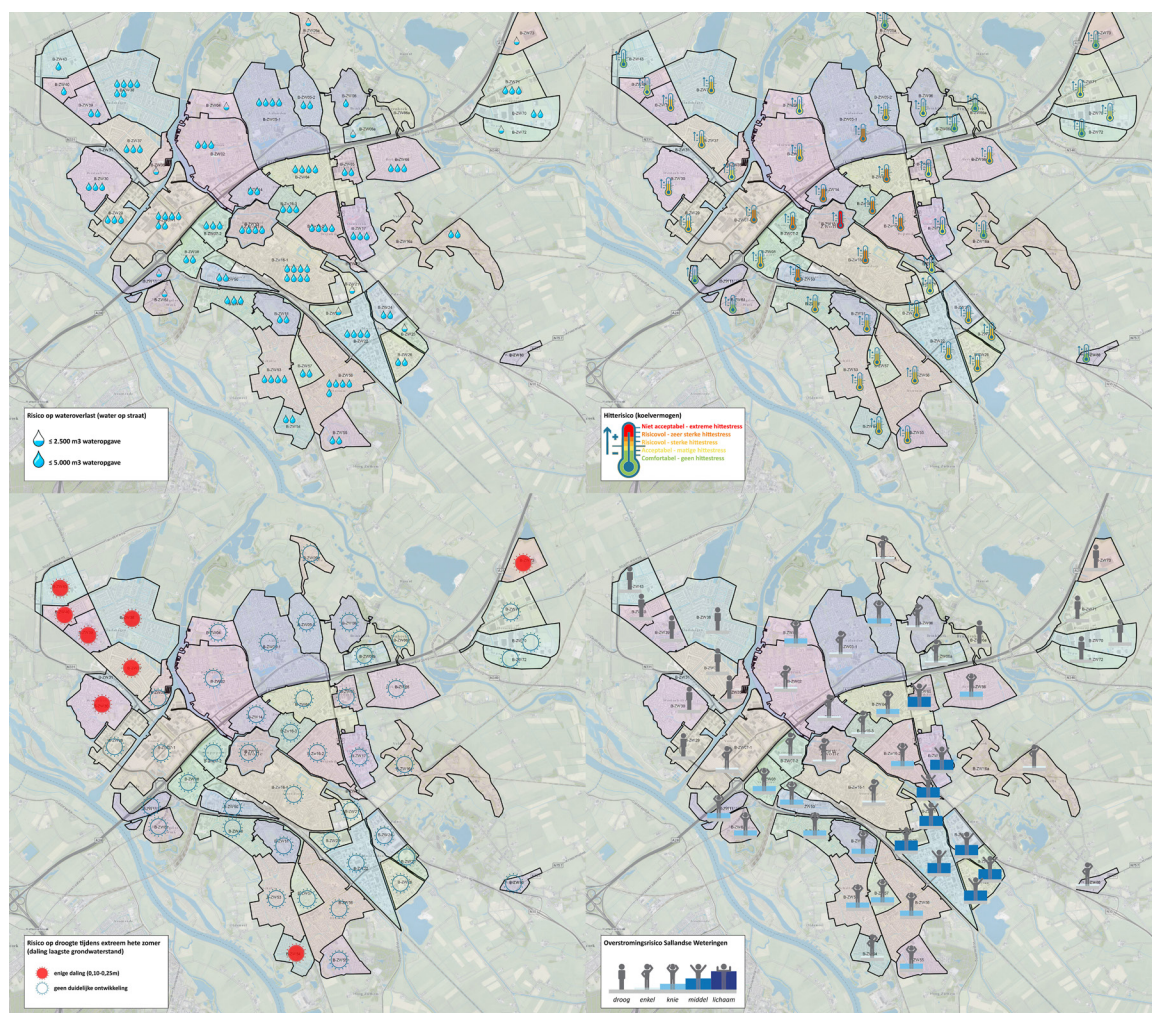
The Zwolle Adaptation Strategy has been developed because of Zwolle’s vulnerability to the effects of climate change, namely, increasing heat stress, flooding and drought. The impacts of climate change are mostly felt through water,

to which Zwolle is inextricably linked because of its history. In Zwolle, water comes from five sides: (1) Lake IJssel – wind/ storm, (2) rain, (3) the main river system of IJssel and Vecht, (4) local and regional water courses of Salland and (5) groundwater. Changes in these water systems also affect the city’s cultural heritage, including historic buildings, the quays along the canal around the city center and the monumental trees.

The city of Zwolle presented its Adaptation Strategy (Dolman 2019b) in July 2019. The strategy’s development was supported by the Zwolle climate team and divided into four constructive phases: (0) inception report, (1) assessment of climate vulnerabilities-climate stress test, (2) risk dialogues and strategy development and (3) implementation agenda vision 2050.

A climate vulnerability assessment or stress test has been performed. The different vulnerabilities to climate change, like pluvial floods, heat stress, droughts and fluvial floods, were placed in mutual perspective and in relation to water quality, vital infrastructure and the mobility and building program, which focuses on reconstruction.

Following a preliminary version of the stress test based on the climate atlas of the local water authority, Zwolle conducted more in-depth stress tests. Different situations were investigated, including nine rainfall events (pluvial flooding), different regional fluvial flooding scenarios (regional water courses) and two heat scenarios (tropical day and warm nights). Various analyses and filters were then applied. This process has provided tailored insight into the level of specific urban land use, like buildings and infrastructure. More information can be found in the geo-portal climate atlas of Zwolle for professionals as well as in the public version



^ Fig. 2 Hot-spot maps of climate change effects (from left to right and top to down): pluvial floods, heat stress, droughts and fluvial floods, 2019 (Source: Nanco Dolman).

of the climate atlas (Municipality of Zwolle 2019).

Not all districts and neighborhoods in the city face the same climate stress challenges. To understand the differences, Zwolle is divided into 55 subareas based on urban typologies/period of construction, watersheds in the (storm) water system and elevation of the surface levels. The climate stress effects (pluvial floods, heat

stress, droughts and fluvial floods) are translated into these subareas in so-called climate hot-spot maps (fig. 2).

The Zwolle Adaptation Strategy is not a generic campaign. Zwolle opts for a targeted strategy in which actors are actively involved in solving specific challenges and co-creating opportunities. And the municipality of Zwolle cannot implement climate adaptation alone. Meas-



ures must also be taken by owners on private property. The municipality is therefore seeking explicit cooperation with private parties and residents. To this end, various city talks, multiple actor meetings with joined interests, urban design ateliers and climate risk dialogue workshops have been organized. These workshops in Zwolle took a thematic approach, including a dialogue about the opportunities of cultural heritage for climate adaptation. Historical water system maps turned out to be an especially important source of inspiration and a foundation for strengthening the urban blue-green network. To accelerate implementation of climate adaptation projects in Zwolle and in the IJssel-Vecht delta region, in 2018 the Climate Campus partnership for professionals was established. And to help private parties and residents, the municipality of Zwolle has appointed a so-called “climate proof” acceleration team. This team provides (internal) road shows about the role of the city and it facilitates, inspires and motivates action in climate adaptation.

Parts of Zwolle are largely paved, with little space for BGI, especially in the areas in and around the historical city center. Moreover, the drainage capacity around the city center (outside the dikes) is limited. Zwolle is actively working in the focus areas with little surface water and a lot of paving. Following the risk dialogues, Zwolle is taking the initiative to draw up so-called “blue-green solution maps” in collaboration with interested parties and residents.

### **Transition to a Blue-Green City**

Zwolle aims to become climate proof by 2050, and it is one of the cities where pilot projects were implemented in the context of the EU Interreg project CATCH (which stands for “Water Sensitive Cities: the Answer To Challenges of

Extreme Weather Events”). This project aims to accelerate the climate resilience process by redesigning cities’ urban water management (Özerol et al. 2020). A city’s path to greater water sensitivity has traditionally followed a sequential path whereby each “state” builds on the development of the previous stage. Zwolle has been classified as one of the “Drained and Waterway” city states.

The development of the Zwolle Adaptation Strategy was one of the CATCH pilots. This targeted strategy to be climate-resilient by 2050 was developed in 2019, in a context of increasingly extreme weather conditions and urban flooding. The Zwolle Adaptation Strategy involves six components, including (1) spatial elaboration in a “blue-green” city, (2) the “new normal” for professionals, (3) private action perspective, (4) regulations, (5) financing and (6) monitoring and evaluation (Dolman 2021). Furthermore, the strategy is built on three blue-green spatial design principles and collaborative spatial planning (table 1). Working toward a livable and attractive blue-green city, is at the forefront of the Zwolle Adaptation Strategy. By strengthening green infrastructure and giving water more space in both the public and private domain, Zwolle has the potential to become the leading blue-green city of the Netherlands. Zwolle is therefore focusing on a blue-green design, based on the three principles included in table 1 which are mapped spatially in figure 3.

The first principle refers to sufficient urban sponges for detaining, retaining and delaying rainwater. In this respect, the city of Zwolle, together with residents and businesses, collectively work to expand Zwolle’s sponge effect at the neighborhood/district level. The second principle is the blue-green city network, within which the sponges can drain excess water and provide discharge and storage. To address this

<i>Blue-Green design principle</i>	<i>Spatial scale</i>	<i>Who?</i>
Sufficient urban “sponges” for detaining (using), retaining or delaying rainwater	Buildings, streets and neighborhoods	City, together with its residents and actors
Blue-green city network on which “sponges” can drain excess water and in which discharge and storage takes place	Neighborhoods, districts and city	City, together with water authorities
Emergency valves for the blue-green network and overflow areas where water can temporarily go in extreme situations	City, region and delta	City, together with water authority, regional authority and neighboring cities

^ Table 1 Design principles for a blue-green city of Zwolle, 2019 (Source: Nanco Dolman).

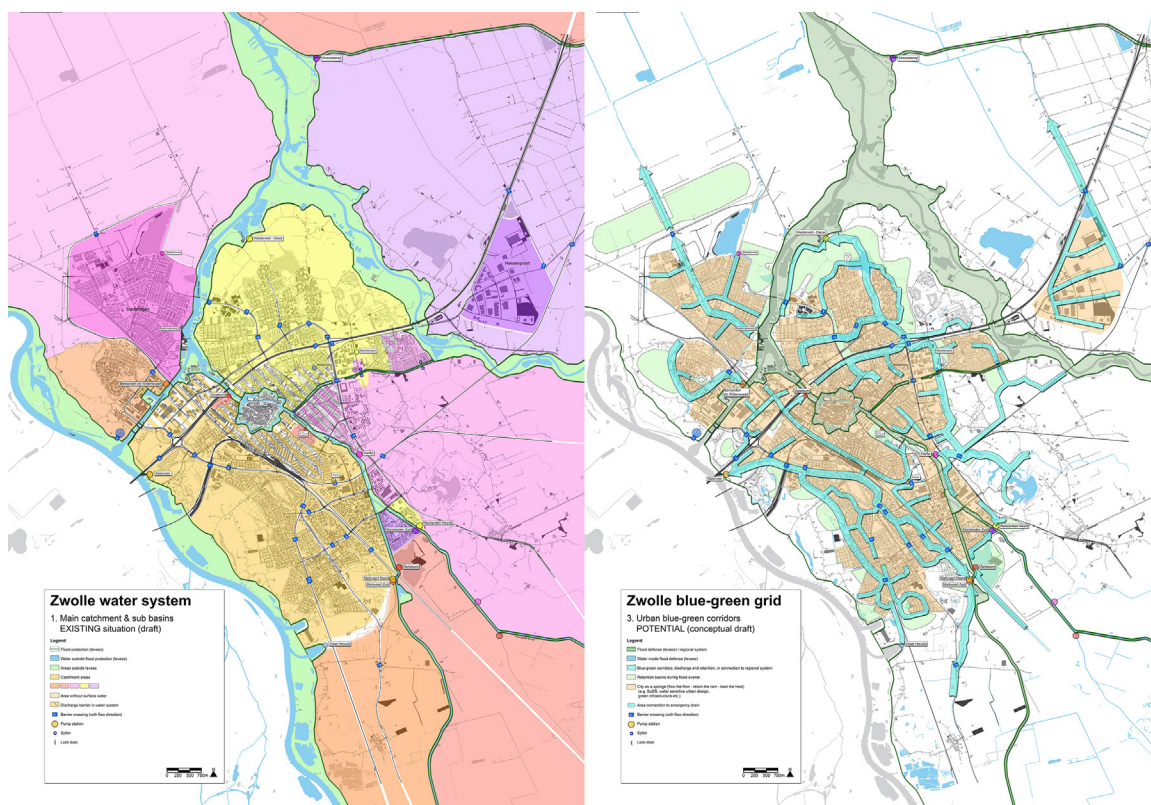
principle, the Adaptation Strategy aims for a blue-green grid at the urban level, which entails a joint responsibility between the city and the water authority. Finally, the third principle refers to emergency valves for the blue-green network and overflow areas where water can temporarily go in extreme situations. This is related to the “Water-resilient Zwolle” plan at the regional water system level, in which responsibility is borne by the central government, the regional authority, the water authority, the city and neighboring cities.

Based on the analysis of the historical and current water system in Zwolle, additional water connections in the city have been proposed. The aim is to create a robust water system that builds on Zwolle’s water heritage. With the cohesive blue-green network (2<sup>nd</sup> principle), the city can develop and expand, with room for urban sponges (1<sup>st</sup> principle) and combating heat stress. The future water system is without dead ends, connected on all sides, has multiple drainage routes and no hydraulic bottlenecks (e.g., bridges instead of culverts).

By preserving and strengthening Zwolle’s historic water and green infrastructure, like the canal

that surrounds Zwolle’s historical city center, it should be possible to restore several missing links in the blue network. This includes daylighting of buried watercourses and restoring them to more natural conditions. An example is the former canal along the Deventerstraatweg in Assendorp, as part of the Spoorzone (railway area)-Hanzeland (re)development. This is part of a larger scale blue-green design, which includes the green corridor (*groene loper*) connecting with the city center, a super sponge in the station square, a green footbridge (*passerelle*) and a new Koggepark.

The municipality of Zwolle also actively engages residents in measures related to climate change. In Zwolle everyone is a delta worker. For example, after a Neighborhood-by-Neighborhood survey conducted in 2016, residents reported concerns about flooding in the Stadshagen district. In this context, the city started the SensHagen project that encourages residents to measure temperature and air quality through sensors in their gardens. There is also a web form where residents can report flooding in the city, indicating the exact location on a map. Another relevant local non-governmental actor is the initiative 50 Tinten Groen (50 Shades



^ Fig. 3 Zwolle water system in current situation (left) and potential blue-green grid beyond 2050, projected on the existing water systems and green infrastructure, 2019 (Source: Municipality of Zwolle).

of Green), organized by and for residents of Zwolle's district Assendorp. This non-profit organization is built on a collective neighborhood approach to make the neighborhood greener and more sustainable, resulting in more than 40 projects up to now. It has received financial support from the city of Zwolle, the regional authority, water authority and the collaborative support of Windesheim Honors College.

## Conclusion and Future Steps

Living with water is an essential part of the cultural heritage in Zwolle. The historic development of the city within its water systems was

recognized as inspiration for climate adaptation in Zwolle. Building on this water heritage, a cohesive blue-green network (city scale) in the city can develop and expand, with room for urban sponges (neighborhood scale) that can combat heat stress. This will create a new natural heritage, recognized and supported by the community, in which various components are interconnected and strengthen the blue-green network as the physical basis of the adaptation strategy to make Zwolle and its surroundings climate proof and adaptive. By implementing Blue-Green Infrastructure (BGI) in three levels of collaborative spatial planning (neighborhood, city, region), Zwolle has been promoted as a frontrunner Blue-Green City in the Dutch





^ Fig. 4 "Pelsertoren" (medieval defensive tower) along Thorbecke canal seen from the Diezerpoorten bridge (Source: Nanco Dolman).

demonstration delta.

Climate change and the current Covid-19 pandemic highlight the value of green spaces in cities. The move toward blue-green futures involves a spatial transition and needs a shift in understanding. Such a step change will also require a culture change, from seeing water and its supply, transport and drainage as add-on infrastructure, to realizing how multifunctional BGI can be an integral part of our living environment. We must invest and build social and institutional capital to create a sophisticated city attuned to an ecologically sustainable lifestyle.

Although part of the current water infrastructure is valued as heritage now, cities like Zwolle have historically invested heavily in single-purpose and (engineered) infrastructure, and consequently, in the maintenance and upkeep of these systems. This calls for developing multifunctional infrastructure, based on regenerative or water-positive measures, like nature-based solutions as nodes of blue-green infrastructure networks. People will benefit from the exposure to nature, but the approach will also enhance biodiversity. This will stimulate urban planners to redesign the urban water management by considering Zwolle as a water catchment and urban ecosystem promoting self-sufficiency. Additionally, sustainable water usage and the transition to a water-sensitive city can be promoted along with other transitions, such as clean energy and a circular economy.

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**Nanco Dolman** is lead expert in Water Resilient Cities at Deltares, the Netherlands, with wide experience in integrated (urban) water and spatial development projects. Nanco has worked in various water and adaptation strategies for delta cities in Thailand, the Netherlands, USA, Bangladesh and China. In 2021–2022 he was the team lead for the “Global Study on Disaster Resilience for Airports,” commissioned by the Coalition for disaster resilient infrastructure (CDRI). From 2011 to 2016 he was part-time lecturer Water Management in Urban Areas at the Rotterdam University of Applied Sciences. He has also been involved in several international “water and climate” and “blue-green infrastructure” research studies, as an applied researcher and field expert, including the EU Interreg NSR – CATCH project (2017–2022). Since 2020, Nanco has been a member of the editorial team for IWA’s *Journal of Water and Climate Change*.

Contact: [nanco.dolman@deltares.nl](mailto:nanco.dolman@deltares.nl)