RESIST

Benchmark analysis regulatory measures in FI

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Abbreviations

BAF	Biotope Area Factor
BGF	Blue Green Factor
BGI	Blue-green Infrastructure
EC	European Commission
ES	Ecosystem Services
FD	Flood Directive
GI	Green Infrastructure
LSD	Large-Scale Demonstrator
NBS	Nature-based Solution
SW	South-West
UNEA	United Nations Environment Assembly
UWD	Urban Wastewater Directive
WFD	Water Framework Directive

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1 Introduction

It has been recognized that the risk for urban floods increases due to a combined effect of climate change, progressing surface sealing, and insufficiently dimensioned and maintained stormwater systems. The effects of climate change on runoff and flooding are anticipated to be stronger in northern areas, compared to other European regions (e.g. Arnell 1999). Climate change already led to noticeable warming and wetting in Northern Europe, the water cycle has intensified and alterations in the flow regime have been observed. In Finland, the precipitation has been estimated to increase in average 10 to 15 % by year 2100, fluctuations in extreme flow events will be more pronounced and summer droughts more common (e.g. Olsson et al. 2015; Veijalainen et al. 2019). Thus, the municipalities must increase the sustainability and climate resilience of the stormwater management systems so as to mitigate the effect of too much and too little rain.

Traditionally, stormwater has been considered as a risk rather than a resource and been conducted through pipes to the nearest water body with minimal delay. However, the capacity of the pipe system cannot be easily adapted to the changing climate nor to land use changes. Thus, the need for large scale uptake of decentralized and easily adaptable nature-based solutions (NBS) for stormwater management has been recognized and is stated in the national stormwater guidance (Kuntaliitto 2012).

The stormwater management in public areas is done by municipalities who have the responsibility for planning, building, and maintaining relevant infrastructure. Many municipalities already implement modern green-grey stormwater infrastructure that is more adaptable for the changing climate. However, in densely built urban centers stormwater must also be retained and detained on the private property as much as possible, to reduce the load on the public system during rain events. The aim of the detention solutions is to provide short term storage capacity and release stormwater to the stormwater conveying systems within a predefined period, e.g. 12h. The retention solutions aim at decreasing the amount of stormwater released to the conveying systems by infiltration, evaporation and long-term storage of the stormwater. While detention systems are designed to empty between rain events, a retention pond normally has a permanent layer of water. Many municipalities have started setting different regulations to direct private landowners to apply local stormwater management solutions. The regulations are typically expressed in the local zoning plans and/or the city level building code. Further, the policy for using zoning provisions to incentivize landowners to apply NBS or other stormwater retention or detention solutions may be outlined in different city level strategies and programs. In absence of national stormwater regulations or guidelines, the municipalities have each developed their own approach.

This report benchmarks stormwater regulations and policies of different municipalities and identifies best practices and development needs for stormwater regulation in Finnish municipalities. First, directives and policies affecting stormwater management and decision making from EU to municipal level are summarized to provide a larger governance context; then stormwater regulation in five Finnish municipalities are analyzed in detail to demonstrate concrete approaches to stormwater management and to highlight challenges and successes. Going beyond policymaking, the report delves into the grassroots level, by presenting results from interviews with local experts that deal with these regulations in their daily work and by examining implementation cases of stormwater regulations and NBS, to find out what kind of stormwater solutions property developers use to comply with the regulations.

This work is part of the RESIST project which aims at increasing the climate adaptation capacity of European regions through implementation of regional climate adaptation pilots (LSDs) and twinning them with follower regions. The overall objective of the SW Finland LSD (T3.1) is to improve knowledge on the effectiveness of NBSs, policies and regulatory instruments to address the rainwater fluctuations and maintain the hydrological balance, as well as to increase capacity and motivation of multiple rural and urban stakeholders to act for and invest in NBS for water retention and detention.

2 Stormwater policy and legislations

2.1 EU policy for stormwater management

Water-related challenges have been addressed through various European Union frameworks, including the Water Framework Directive 2000/60/EC, the Urban Wastewater Directive 91/271/EEC, the EU Floods Directive 2007/60/EC, and the Groundwater Directive 2006/118/EC. The Water Framework Directive aims to ensure the protection and preservation of water, promote sustainable use, ensure long-term availability, and protect aquatic environments. This is achieved through the establishment of river basin management plans, water quality monitoring, and measures to reduce and prevent pollution. The directive also strives to achieve a good status of surface water and groundwater by 2027. The Urban Wastewater Directive focuses on protecting the environment from the adverse effects of urban wastewater through the treatment of wastewater. The EU Floods Directive aims to establish a framework for the assessment and management of flood risks, with the goal of reducing consequences on human health, the environment, cultural heritage, and economic activity. It emphasizes sustainable flood prevention methods, including sustainable land use practices, water retention and detention, and controlled flooding. The Groundwater Directive is dedicated to protecting groundwater against pollution and deterioration, with the objective of protecting the quality and quantity of groundwater and preventing pollution and deterioration. Member States are required to develop measures to ensure environmental quality, public participation, and information.

Similar to other water-related concerns, stormwater is approached in various contexts. Stormwater is not directly addressed most of the time, but indirect references arise in relation to the broader context. The management of flood risk includes the management of stormwater, as indicated in the EU Directive 2007/60/EC, where urban flooding is recognized as one of the types of floods emerging in Europe. Furthermore, stormwater could be related to groundwater through groundwater recharge. Because, stormwater can contribute to groundwater recharge, it can carry harmful substances that can affect groundwater quality (Directive 2006/118/EC). While stormwater is not explicitly stated, in certain cases, for example, in wastewater-related directives, stormwater issues can be related. Directives such as 2000/60/EC and 91/271/EEC emphasize pollution prevention in surface waters and proper wastewater treatment, including measures to regulate the quantity and quality of stormwater runoff and address potential consequences. In urban areas, stormwater is often considered a mixture of domestic and industrial wastewater, along with runoff rainwater; therefore, relation to stormwater exists in the context of urban areas where stormwater might be mixed with other types of wastewaters.

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2.2 EU policy for green infrastructure, biodiversity, and nature-based solutions

Recognizing the important role NBS play in the global response to climate change and its social, economic and environmental effects, Nature-based solutions are since 2022 the object of a UNEA resolution which includes a definition of nature-based solutions (NBS) multilaterally agreed at the Fifth Session of the United Nations Environment Assembly (UNEA-5.2): NBS are defined as 'actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits. It is an umbrella term for similar various policy-oriented concepts, such as ecosystem-based adaptation and natural water retention measures, the latest having been developed in the frame of the Water Framework Directive (WFD) and the Floods Directive (FD) (European union 2014).

Nature-based solutions (NBS) represent a sustainable and effective approach to addressing global societal challenges, while also ensuring the conservation of natural ecosystems and biodiversity (Cohen-Shacham et al. 2016). They offer a range of advantages over traditional grey infrastructure. First, NBS deliver multiple benefits, such as contributing to biodiversity enhancement, supporting ecosystem services, and promoting human well-being. Moreover, NBS contributes to the resilience of ecosystems and communities, and prepares them against the impacts of climate change. The co-benefits of NBS further extend to the reduction of greenhouse gas emissions as well as the improvement of air and water quality. Additionally, NBS demonstrates cost-effectiveness, proving to be more economical than traditional engineering solutions, especially in the long term.

Decision-making processes have been developed to actively promote the integration of NBS into water management strategies to ensure sustainable water management and climate resilience in cities. Notably, challenges associated with stormwater management have been recognized in the European Union (EU), national and local policymaking, and the benefits of incorporating NBS into the approach have been acknowledged. Local policymaking has utilized stormwater regulations to guide the implementation of NBS.

The importance of green infrastructure (GI) and NBS is recognized in the EU, and several actions have been taken to promote the use of these structures and solutions. Major strands for making this visible are through embedment in policy instruments, funding projects through the Horizon 2020 now Horizon Europe program, publishing reports, and conference proceedings (Davies et al. 2021). The EU has proposed several important strategies for promoting green infrastructure, NBS, and biodiversity. The European Green Deal is a comprehensive plan and roadmap for transforming the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of

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greenhouse gases by 2050 or that no one is left behind (COM 2019 640 final). The Green Deal is covering a wide range of EU policies, including on energy, transport, agriculture, the circular economy, biodiversity, and sustainable finance. In addition, several initiatives such as the Green City Accord, Green Capital, and Green Leaf are there to encourage cities to respond to environmental challenges and showcase their actions and solutions. (European commission, Energy,Climate Change Environment, Urban environments 2023.

The Green City Accord is a European initiative that started in 2021. Its goal is to promote sustainable urban development and accelerate the implementation of relevant EU environmental legislation. Signatory cities are committed to addressing the areas of environmental management, which include air, water, nature and biodiversity, circular economy and waste, and noise. The initiative includes 108 European cities, of which 8 are from Finland. If a city signs the green city accord, it also engages cities to support the European Green Deal.

The European Green Deal is implemented by the European Commission through the adoption of a set of strategies and other policy initiatives. The EU Biodiversity Strategy for 2030 aims to ensure that the biodiversity in Europe is in path of recovery by 2030. The aim was to develop and extend the network of protected areas and create a restoration plan (COM 2020 380 final). This also implies investments in blue-green infrastructure (BGI) and NBS. The strategy also involves a chapter about green infrastructure. The strategy supports this process with Urban Greening Plans, which is a framework for municipalities and cities to help them understand the gaps in biodiversity and add natural elements to cities. The Biodiversity Strategy also recognizes the importance of water for biodiversity and ecosystems and highlights the need to ensure good surface water and groundwater quality (COM 2020 380 final p. 13). As mentioned, surface water and groundwater quality are closely related to stormwater because stormwater can be considered a type of surface water. Therefore, the measures outlined in the strategy to improve water regulation, flood protection, and nutrient pollution removal can also be considered to cover stormwater management actions. All actions aim to achieve good status or potential of all surface waters and good status of all groundwater at latest by the year 2027, as required in the Water Framework Directive 2000/60/EC.

The EU Green Infrastructure Strategy was developed to preserve, restore, and enhance green infrastructure (COM 2020 249 final). A key focus of this strategy is to conserve and enhance natural capital, promote sustainable growth, and achieve the Europe 2020 objectives. The strategy also seeks to increase awareness of Ecosystem Services (ES) to policymakers and increase understanding and know-how on replacing grey infrastructure with green alternatives. According to the Green Infrastructure Strategy, GI plays an important role in stormwater management. GI solutions can improve water quality and reduce risk of flooding (COM 2020 249 final p. 2). Additionally, they can provide benefits, such as increasing biodiversity, improving air quality, and reducing the urban heat island effect (Kim & Song 2019, Nastran et al. 2019, Hewitt et al. 2020, Choi

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et al. 2021). GI solutions are also presumed to be more cost-effective and sustainable compared to grey infrastructure (Ncube & Arthur 2021). Therefore, incorporating GI into stormwater management has multiple benefits to the environment and society. This is why the strategy states the necessity of including the principles of GI in the focal fields of politics.

In addition to strategies, the EU Nature restoration Law will soon provide a new set of rules to increase green spaces in cities, towns and suburbs (COM 2022 304 final). The targets would ensure that there is no net loss of green space by 2030, compared to the year when the nature restoration rules enter into force (unless the urban environment has already 45% of green space) and also increase in the amount of tree cover in cities.

2.3 National Stormwater policy in Finland

In Finland, the legal framework for stormwater management is comprised of several laws, rather than a dedicated policy. Stormwater is considered within the context of these laws, which aim for the sustainable use and management of water. All legislation is available in the online database Finlex (www.finlex.fi) owned by Finland's Ministry of Justice. Generally, all water related laws aim for sustainable use and management of water.
The Land Use and Building Act (Maankäyttö- ja rakennuslaki) 132/1999 is the most important piece of legislation framing the governance of stormwater in cities. This Act seeks to promote ecological, economic, social, and cultural sustainability in the organization of construction areas, and ensures the quality of planning and public participation. Chapter 13a of the Act is dedicated to stormwater management and establishes the fundamental principles and regulations for stormwater management in municipalities and private properties. This includes the identification of responsible actors, stormwater regulation, stormwater plans, and stormwater fees. According to the Act, property owners or holders are responsible for managing stormwater on their property, while the municipality is responsible for stormwater management I public areas. Property owners must discharge stormwater to the municipality's stormwater system if on-site infiltration is not feasible. The municipality also has the authority to supervise and monitor different stormwater actions, and may establish its own regulations regarding stormwater quality, infiltration, retention, monitoring, management, stormwater systems, and other related matters. The Act is currently undergoing comprehensive reform, and the revised legislation is set to take effect in 2025.

In Finland, water services are organized by municipalities. Water services include the water supply, domestic water treatment and distribution, and wastewater treatment. More general information about water services in Finland can be found on the website of the Ministry of Agriculture and Forestry of Finland (www.mmm.fi/water) and the Suomi.fi website (https://www.suomi.fi/citizen/housing-and-construction/construction-and-properties/guide/construction-and-waste-management/water-services). Vesihuoltolaki (The Water

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Service Act) (119/2001) applies when stormwater drainage is provided by a water utility. The Act establishes spatial requirements for water utilities and divides the responsibilities of water management between municipalities and water utilities. The municipality must collaborate with the water utility to develop water management, and the municipality and water utility can agree that the utility will manage stormwater drainage. This action is governed by the Land Use and Building Act and is subject to the condition that management is done with care and does not cause disproportionate costs. If no agreement exists, stormwater management is carried out according to the Land Use Act, based on the site plan, stormwater plan, street plan, or general plan.

Vesilaki (Water Act) 587/2011 promotes and consolidates the use of water resources and aquatic environments in a sustainable way and seeks to reduce the harm caused by the exploitation of water resources. The Act defines aspects such as ownership of water bodies, rights and responsibilities regarding these bodies, the right to use water, maintenance, and upkeep of structures in aquatic environments, changing the flow of a natural stream, conservation of aquatic ecosystems, and permission for water management projects.

The purpose of the Flood Risk Management Act (260/2010) is to reduce flood risks and consequences, and advance flood preparedness and flood risk management. The law defines the responsibilities and tasks of authorities in the case of a flood, as well as regarding the assessment of flood risks and the definition of significant flood risk areas. Excess stormwater that increases flood risk in urban areas, is identified as a potential threat that has to be acknowledged and managed.

In addition to water laws and legislations, Finland has also taken actions to protect biodiversity and promote green infrastructure. In response to the EU's policies for green infrastructure and biodiversity the Ministry of the Environment prepared the National Action Plan for the Conservation and Sustainable use of the Biodiversity in Finland for the period 2013-2020. The strategy was created for the conservation and sustainable use of biodiversity in Finland as well as to support the implementation of the Convention on Biological Diversity and the EU Biodiversity Strategy to 2020 (Ympäristöministeriö 2020). The plan recognizes the importance of green infrastructure and aims to incorporate the formation of ecological networks into land use planning. Promoting green infrastructure also helps water management in cities. As this strategy stopped in 2020, the new strategy is currently underway. A new Biodiversity Strategy and an action plan to 2030 will further enhance the protection of biodiversity and restoration of degraded ecosystems (Finland's biodiversity policy n. d).

2.4 Regional and municipality level policies in Finland

Municipalities have a big role in providing and controlling stormwater management in Finland. This creates a need for nationally coherent practices and standards. The Association of Finnish Municipalities have prepared a stormwater guidebook (Hulevesiopas) for Finnish municipalities to

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cover focal aspects of stormwater management from unified terminology to basic principles of planning, organizing, supervising, implementing, and communicating about stormwater management (Kuntaliitto 2012). Originally published in 2012, the guidebook was subsequently updated in 2017.

The stormwater guidebook establishes fundamental principles for the management of stormwater in municipalities across Finland. The primary objective of stormwater management is to proactively prevent the formation of stormwater and reduce its volume through retention and infiltration systems. Emerging stormwater must be detained as much as possible, before being directed to stormwater pipelines and receiving waterbodies. To reach these principles the stormwater guidebook encourages Finnish municipalities to draft a stormwater management plan and manage the stormwaters at watershed scale.

The stormwater guidebook defines nature-based stormwater management as stormwater management solutions that uses elements from the natural water cycle (Kuntaliitto 2012 p. 11). These solutions can be divided into four types depending on the use case of the solution: stormwater retention and infiltration, management, conduction, and detention (Kuntaliitto p. 19). Solutions can be implemented in two scales, local and regional scale with different purposes in the overall process. Different types and scales can occur inside the same water management plan.

In response to the guidelines, many Finnish municipalities have crafted their own stormwater management plans as suggested by the Association of Finnish municipalities. The management plan serves as a framework for visions, principles of operation, and timeframe for implementing actions (Kuntaliitto 2012 p. 22–23). This sets long-term objectives for development and assures common principles amongst actors. The plan is used as guidelines for local development plans, city planning and at the same time it gives guiding to the building inspection. In many cases stormwater is also considered in municipal environmental protection regulations.

2.5 Overview of the land use planning system in Finland

In Finland, the land use planning process is based on Maankäyttö- ja rakennuslaki (the Land Use and Building Act) 132/1999, and planning follows a clear zoning system. The use of the entire country's areas is guided by the National Land Use guidelines, which aim to promote sustainable development and comprehensive planning of areas (Similä et al. 2017). The National Land Use guidelines are the guiding basis for planning. It is noteworthy that ongoing reforms to the Land Use and Building Act will impact certain aspects of the land use planning process.

The land use planning is divided into three different levels (Figure 1), which are the regional plan, city-level master plan and the local or bloc level zoning plan (Similä et al. 2017). The regional council is responsible for drafting the regional plan, which covers the entire county and resolves the use issues of areas that cross municipal borders, such as connectivity and broader environmental values. The general plan is more detailed than the regional plan and its purpose is to guide the development of the municipality's land use and coordinate the various functions of the municipality (Maankäyttö- ja rakennuslaki 132/1999). The site plan is the most precise of the plan levels, which gives detailed instructions for organizing, building, and developing the use of areas. The site plan indicates the necessary areas for different purposes and guides the construction as required by the local conditions, urban and landscape image. Municipalities are responsible for preparing and approving general and site plans for their own areas (Kuntaliitto 2012).

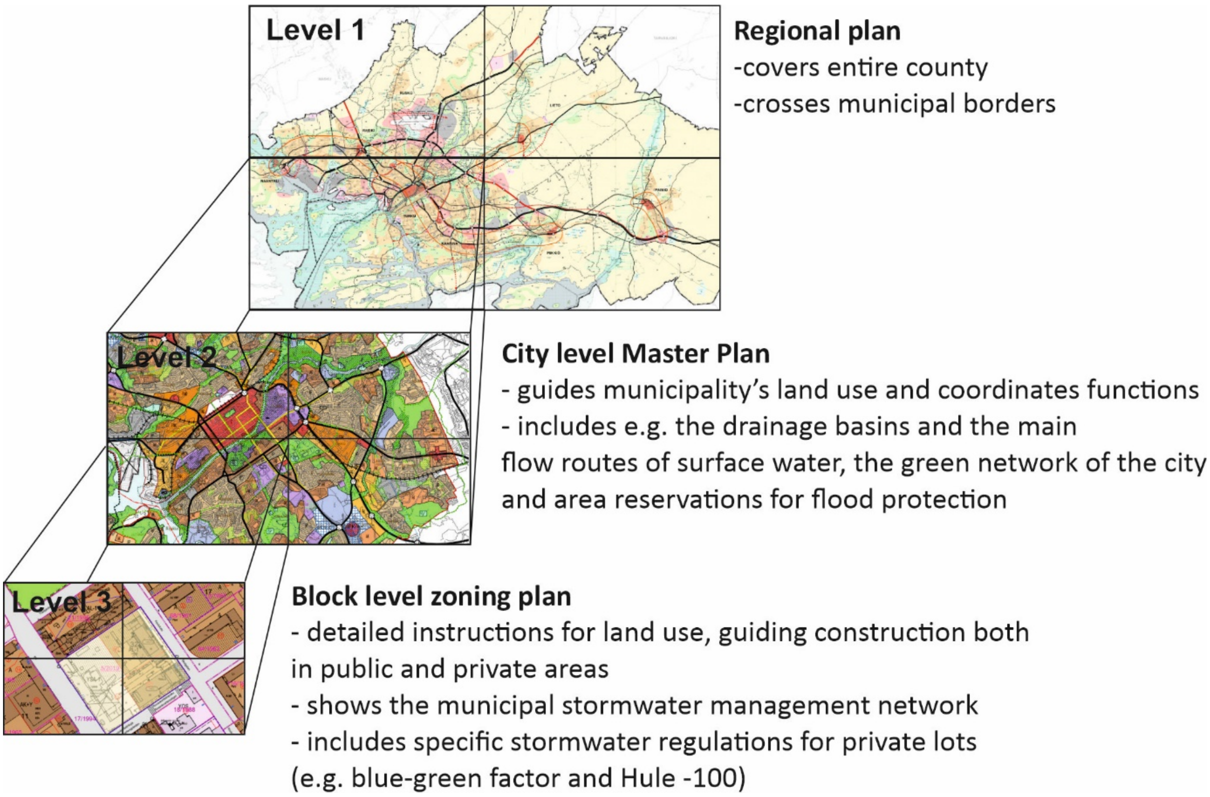

Figure 1 The land-use planning levels in Finland

Maankäyttö- ja rakennuslaki (The Land Use and Building Act) 132/1999 obliges municipalities to also draw up a building code, the purpose of which is to issue regulations suitable to the municipality's conditions. The purpose of the regulations is to guide planned construction suitable for the area, the regulations may concern, for example, the construction site, the size of the building, plantings, and the organization of water supply. The building code supports the municipality's zoning, and its goal is to strengthen the municipality's identity and preserve the municipal characteristics. The land use and building act, general and site plans and the provisions of the Finnish building regulations collection take precedence over the building order.

Stormwater is considered at different plan levels as required by their accuracy (Kuntaliitto 2012). In the regional plans, markings can be related to groundwater, Natura 2000-areas, water bodies, and other objects important in terms of water protection. The city Master plan, on the other hand, should consider the increase in the amount of stormwater, potential flood areas and water quality problems. The plan markings can concern, for example, the delay volume, and the plan can indicate indicative locations for wetlands, pools, and ponds. The local zoning plan regulations set requirements for stormwater management, such as delaying, absorbing, and cleaning, and in connection with these, sufficient space must be allocated to temporary ponding. These space allocations to stormwater solutions are defined based on a separate plan drawn up in connection with the site plan.

2.6 Stormwater planning and regulation methods in Finland

In land use planning blue-green-infrastructure is often considered together with stormwater management, landscape values, green corridors, parks and recreational areas (Di Marino et al. 2019). To include blue-green elements to new constructions different types of Blue-Green Indexes have been developed. Perhaps the most well-known green factor calculation tool in Europe is the Biotope Area Factor (BAF), developed in Berlin already in the 1980’s (https://climate-adapt.eea.europa.eu/en/metadata/case-studies/berlin-biotope-area-factor-2013-implementation-of-guidelines-helping-to-control-temperature-and-runoff).

Numerous European cities have used the BAF from Berlin as a basis for developing locally adapted calculation tools. The general idea of these calculation tools is to calculate the ratio of the indexed green area compared to the total lot area. The local adaptations normally concern the coefficients and weight given to different green elements as well as the incorporation of water retention considerations such as stormwater management measures.

The Blue-green factor (BGF) calculation tool is a Finnish adaptation of BAF, and it was initially developed in Finland by the city of Helsinki and then developed further by the iWater project in 2016-2018 (Helsinki 2016). Since then, several Finnish cities have taken it into use and made some local adaptations to it. It is typically used in combination with a minimum blue-green factor score requirement or recommendation in the zoning regulations of a planning area or the city building code. When applying for a building permit, the property developers are required to present the calculation how they are going to reach the blue-green factor target level. The different green or permeable surfaces as well as additional green elements, such as trees and pollinator meadows each have different coefficient or weighing factor and by using different elements the planners have various alternatives for reaching the required score. Typically, these weighing factors differ between the cities.

The BGF tool also includes the stormwater management structures and in some cities the stormwater detention requirement has been incorporated into the blue-green factor, whereas in others there is an additional requirement for stormwater detention. The aim of the detention is to avoid overloading of public stormwater sewers during heavy rain events. The most commonly used stormwater detention requirement in Finland is one cubic meter of detention volume per 100m2 of impermeable surface, the so-called Hule-100 rule. The requirement is based on a rain statistically happening in Finnish cities once in five years, with a duration of 10 minutes, intensity of 150l/s*ha and precipitation of about 10 mm. However, many cities have developed their own version of this regulation. For example, many cities have added a minimum and maximum time range for the emptying of the detention structure, to avoid the installation of direct flow through structures or structures that do not empty at all.

3 Benchmarking stormwater regulations

There are (2021) 309 municipalities in Finland. The smallest has only 111 inhabitants, while the largest, Helsinki has approx. 670 000 inhabitants. The stormwater regulations are a concern only for those municipalities that have a significant urban centre. For this benchmarking study, five municipalities that are all forerunners in environmental actions, but representing different sizes and different regulation approaches were selected (Figure 2). The current policies and practices of stormwater regulation and taxation in these municipalities were recorded, based on information found from different municipal documents and programs and recent zoning plans. An overview of the regulations is presented in Table 1 and a more detailed description of the regulations in each municipality in the paragraphs below.

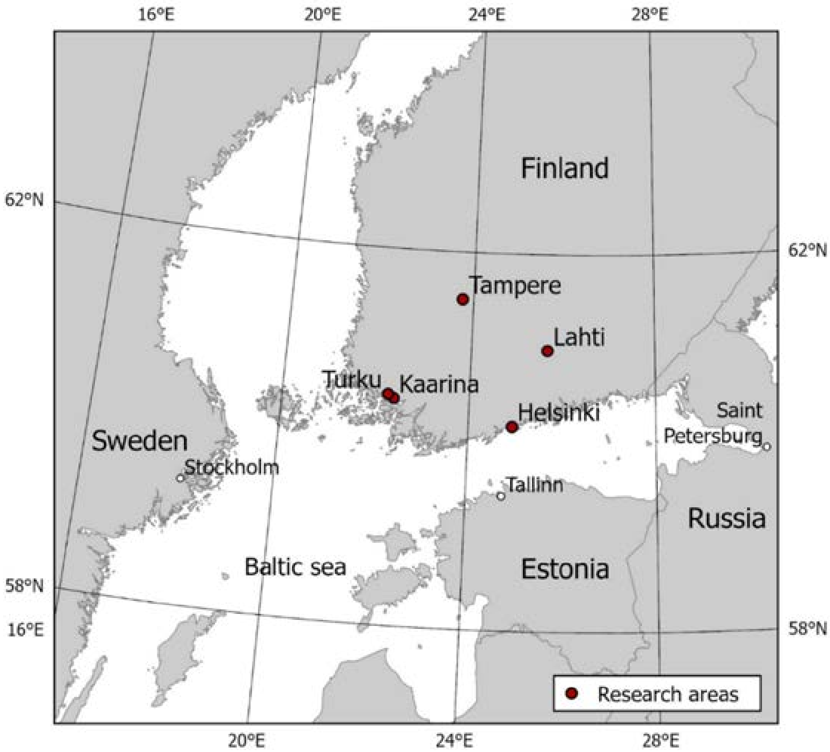

Figure 2 The location of the benchmarked municipalities

Table 1 Summary of stormwater policy and regulations in the case municipalities

City	Stormwater programme	Stormwater fee	Blue-Green factor	Hule-100 rule
Turku	Yes	No	Yes (since 2021)	Yes
Tampere	Yes	Yes, in stormwater network areas	Yes (since 2020)	Yes
Helsinki	Yes	Yes, in stormwater network areas	Yes (since 2016)	Yes
Lahti	Yes	No	No	Yes
Kaarina	No	No	Yes (own calculation tool)	Yes

3.1 Turku

6th largest city in Finland, population: approx. 200 000 inhabitants

3.1.1 Stormwater policy and programme

Turku city has committed to advancing nature-based local stormwater management, water protection and greening of the city in several different agreements and policies, including the Turku city climate programme 2029 (Turku 2022a), City strategy 2030 (Turku 2022b), Baltic Sea Challenge 2024-2028, Mission on 100 Climate-Neutral and Smart Cities by 2030 (Cities Mission) and the EU Green city Accord (2020). The Turku city stormwater programme is currently being revised. The previous stormwater programme is from 2016 and it already set goals for increasing green infrastructure in stormwater management.

3.1.2 The building code

The Turku city building code (Turku 2021a) puts a number of requirements for stormwater management in the properties. It states that stormwater should be treated, reused and/or retained in the property, whenever it is possible and recommends that the detention capacity should be one cubic meter per 100m^2 impermeable surface. Conducting stormwater to the sewage lines is forbidden and a stormwater plan must be included in the building permit documentation.

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The building code of Turku also includes a specific paragraph about green efficiency of the lots. It sets the target levels for the blue-green factor in areas that are reserved for residential, services and offices, commerce and businesses or industrial and logistics use, thus covering all types of new building. In residential areas, lots with single or double family houses are exempted from the requirement.

3.1.3 Blue-green factor

The blue-green factor was piloted in Turku in Kirstinpuisto area in 2020 and it has been in use in new planning areas in Turku since 2021. As it is included in the city building code, it is required in all planning areas, even when the zoning provisions do not mention it. It is also applied to retrofitting cases, where new buildings are added to the existing city structure. The building code states the baseline target levels for green areas according to the land use, but in some plans, where the lot characteristics do not allow use of green infrastructure (e.g., renovation sites, where the old building remains) lower levels of blue green factor score is allowed. The blue-green factor target level, stormwater detention volume requirement, and the lot size and building surface are entered into the calculation sheet by the planner. Different types of permeable surfaces can be entered into the calculation sheet by the lot planners, but the soil type (whether it is permeable or not) is not considered by the tool. Different solutions that are promoting biodiversity get higher weighing factors or additional points for the BGF calculation. For example, the semi-intensive and intensive green roofs, which provide more benefits for both biodiversity and stormwater management have higher weighing factors in the BGF calculation.

3.1.4 Stormwater detention regulation

The building code of Turku gives a recommendation of one cubic meter stormwater detention volume per 100m^2 impermeable surface (Hule-100). However, as this is stated as a recommendation, a detention requirement is also included in the detailed planning provisions. Usually Hule -100 requirement is used, but in some cases also lower detention requirements have been used, for example because of the vicinity of the sea. For the Hule -100 rule it is stated that it should take between 0,5h to 12h for the detention structure to get empty, after it has got filled with stormwater. In the lots where BGF tool is used, the tool automatically counts the impermeable surface by subtracting the sum of permeable areas that have been entered into the calculation sheet from the total lot area and then gives the required detention volume. The stormwater detention structures are entered into the BGF tool as detention volumes.

3.1.5 Stormwater funding and fees

Currently no stormwater fee is collected. The city council decided to abolish it in 2021, when it had been in use only for less than three years. Since then, the stormwater management has been financed from the general city budget.

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3.2 Tampere

3rd largest city in Finland, population: Approx. 250 000

3.2.1 Stormwater policy and programme

Tampere city has been ranked A by the Carbon Disclosure Project and listed among the EU Commission's 100 Carbon Neutral and Smart Cities. Within Unalab -project (2017-2022) Tampere developed and piloted NBS in stormwater management. The infrastructure board of the Tampere city council accepted the new stormwater programme on 24th October 2023. The old programme was from 2012 and it already set targets for decentralized stormwater management, water retention and flood management as well as increasing the city green. The new programme sets targets for restoring natural water balance and biodiversity, protecting the quality and quantity of both groundwater and surface water, promoting multiuse stormwater solutions, reducing flood risks and advancing separation of wastewater and stormwater. The programme states for example, that open nature-based stormwater systems have more capacity in case of flooding situations and thus all main stormwater conduction systems should be mainly based on open channels and ditches. The drainage basin-based stormwater management and risk assessment is emphasized, and management targets are defined according to the characteristics of each drainage basin.

3.2.2 The building code

In the Tampere city building code the mixing of stormwater and wastewater is prohibited and local infiltration of stormwater is recommended. The present building code is from 2014 and there is a plan to renew it in 2024. The new stormwater programme states that the stormwater parts of the building code will be renewed and 1.1 m3 detention requirement for 100 m2 of impermeable surface will be set to all properties.

3.2.3 Blue-green factor

Tampere has developed its own version of the blue-green factor tool during 2019-2023. The blue-green factor has been applied to zoning plans since 2020 in densely built planning areas and areas with sensitive water bodies or special nature values. The calculation sheet of Tampere city calculates automatically the blue-green factor target level for the lot according to the land use. The target levels for residential areas, services and offices, commerce, and businesses and industrial and logistics are 0.8; 0.7; 0.6; and 0.5 respectively. These same land-use categories and target values are also used eg. in Helsinki and Turku. Lower target levels are used if there is no ground water or sensitive water bodies or special nature values in the area or if the soil is impermeable. In some zoning plans the target levels are set case by case.

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3.2.4 Stormwater detention regulation

The stormwater management solutions and the detention requirements are included in the BGF calculation tool, thus no separate stormwater regulations are applied in areas where the blue-green factor target levels are set in the zoning regulation. In addition to conventional underground stormwater detention tanks, the Tampere blue-green factor calculation tool considers the detention space of NBS, and calculates it based on average depth of the open storage layer and surface of the detention space. The water storage space in the filtering layers of stormwater structures or green roofs is not included in the calculation.

In areas where the blue-green factor is not used, there is often a detention requirement stated in the zoning plan. Instead of the Hule -100 rule commonly used in other Finnish cities, Tampere has developed an own version, Hule -43, which takes into account the climate change (the detention requirement is 1.1m^3 instead of 1.0 m^3/100m^2 impermeable space) and a minimum and maximum time range for the emptying of the detention structure. Recently Tampere has introduced a new version (Hule -51), which sets a minimum value for how many percentages of the detention space must be implemented using a raingarden. The goal of this new modification is to push towards the use of nature-based stormwater retention solutions.

3.2.5 Stormwater funding and fees

Stormwater fee is collected from all areas where the municipality has developed a stormwater network. These areas exclude e.g., areas draining directly to a lake and where there is no stormwater network. There are 5 different categories of fees, according to the purpose of the buildings, the fee is calculated according to the number of buildings and the area of the lot. The maximum reasonable amount of fee is determined in each category.

3.3 Helsinki

a capital city, population: Approx. 670 000

3.3.1 Stormwater policy and programme

The Helsinki city stormwater programme was published in 2018 to advance the implementation of the Helsinki city strategy 2017-2021 and the Helsinki city climate adaptation strategy 2017-2025. In addition Helsinki is also a signatory of EU Green City Accord. The city strategy has ambitious targets for densification of the city structure and sets targets for increasing green multibenefit stormwater structures. The climate adaptation strategy emphasizes the need for increasing resilience during both draughts and floods. The first target set in the stormwater programme is to increase the role of stormwater in maintaining biodiversity, increasing attractiveness of the living environment and in improving the state of surface water bodies in the urban environment. The other targets include controlling risks from stormwater and decreasing amount of stormwater in the wastewater sewers as well as improving the process of stormwater management in the city organization.

3.3.2 The building code

The new building code of Helsinki was accepted by the city council in May 2023 (Helsinki 2023). It states, as usual, that each lot has to have a stormwater plan and that the stormwater must not be conducted to the wastewater sewers and that the stormwater must be locally infiltrated into the ground whenever it is possible. In addition, it states that water detention and conduction structures that are on the surface of the ground, such as ponds, swales, raingardens and open ditches have to be given a priority over underground structures, such as stormwater pipes and storage cassettes. The new building code also includes a chapter about preservation of natural and cultural values. This chapter e.g., states that trees and existing natural vegetation must be preserved whenever possible and that they must be protected from damage during the construction phase. Cutting trees requires a permit and the building inspection may require planting of new trees for replacement. The building code also states that all permit applications for new buildings must include a blue-green factor calculation sheet that shows how the required blue-green factor target level is reached in the property. Lots with single or double family houses are exempted from this rule. (Helsinki 2023)

3.3.3 Blue-green factor

Helsinki city has made a commitment to use the blue-green factor (BGF) in new planning areas in its Carbon-neutral Helsinki 2035 -action plan (Helsinki 2018). Since 2019 the city has instructed the planners to use the BGF in all new zoning plans, unless the characteristics of the site make it impossible to reach the BGF target levels. In 2021 the city carried out a study about the use of BGF in planning and its effectiveness in increasing city green. According to the study, in 2021 the BGF was used in about 50% of all zoning plans that included residential lots. Typically, in areas where new buildings were planned in an existing, already densely built environment, the BGF was replaced by separated provisions concerning e.g., stormwater detention, green roofs and/or saving of existing vegetation. The BGF had been used also in some areas reserved for services and commerce, however in 2021 it had still not been used in any lots reserved for industrial and logistics activities (Helsinki 2021). During the first years of implementation the BGF target levels were expressed as non-binding recommendation in the zoning provisions. However, these were found ineffective in increasing city green and since 2021 the BGF target levels are set as binding regulations (Helsinki 2021).

Similar to the BGF calculation tool in Tampere, the Helsinki tool automatically calculates the BGF target levels based on the choices in the sheet – the land use type and the depth of the permeable soil layer. If more that 50% of the lot is covered by a deck yard (a yard that is based on a roof of an underground parking space), the tool recommends using green roofs and if there are natural areas in the vicinity saving of existing vegetation is recommended.

3.3.4 Stormwater detention regulation

The detention requirement is incorporated and calculated automatically by the BGF calculation tool, in a similar way than in Tampere. The requirement is 1 m^3 of detention space per $100m^2$ of impermeable surface.

3.3.5 Stormwater funding and fees

A stormwater fee is collected from all areas where the municipality has developed a stormwater network, where there are combined sewers or where a stormwater network is planned in the near future. The fee is collected from all properties in these areas, even if it has not joined the stormwater network. The fee comprises joining fee and an annual basic fee and its amount depends on the purpose and size of the building(s) on the property.

3.4 Lahti

9th largest city in Finland, population: Approx. 120 000

3.4.1 Stormwater policy and programme

Lahti was the European Green Capital in 2021 and it is a signatory of the EU Green City Accord. It has taken ambitious environmental targets, such as carbon neutrality by 2025 and protection of the surrounding lakes. Lahti is also located in a classified ground water area, where the maintenance of natural water balance and protection of the ground water are essential. The stormwater programme is from 2011 and it sets targets and actions for reducing damages from excessive stormwater, for improving quality of groundwater and surface water, promoting biodiversity, and improving the stormwater governance process within the city organization. Need for climate change adaptation is described in the introduction but is not reflected in the action plan. (Lahden seudun ympäristöpalvelut 2011)

3.4.2 The building code

The building code states that stormwater is to be infiltrated locally where the soil properties allow to do so. It also states that in ground water areas permeable surfaces are to be used in the construction of the yards, unless the land use poses a risk for water pollution and requires use of protective impermeable layers. If local infiltration is not possible, the stormwater must be conducted to public stormwater system. Conducting stormwater into public green spaces requires a permit from the municipality. (Lahti 2013)

3.4.3 Blue-Green factor

Lahti city does not use blue-green factor tool nor has yet set numerical targets for increasing city green. There is however, a plan to start using the blue-green factor in the future.

3.4.4 Stormwater detention regulation

In Lahti stormwater detention requirements are not systematically included in the zoning provisions. The use of the detention requirements in the plans is decided based on the characteristics of the planning area and there must be always a specific reason for setting detention requirements, such as insufficient capacity of the stormwater network downstream of the planning area. In such cases Lahti has used either the Hule-100 rule or a detention requirement based on case-specific dimensioning.

As Lahti is located on a classified groundwater area, some special requirements are applied for protecting groundwater, e.g., ban of infiltrating stormwater from areas with dense traffic.
The city is currently developing a new master plan, which will include defined focus areas for stormwater management. When the master plan comes into effect, retention and detention requirements will be applied in areas where the quantitative stormwater management has been set as a target.

3.4.5 Stormwater funding and fees

No stormwater fee is collected.

3.5 Kaarina

32nd largest city in Finland, population: Approx. 36 000

3.5.1 Stormwater policy and programme

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Kaarina city has an ambitious climate programme (Kaarina 2021), but it focuses on reducing carbon emissions and does not list any actions for climate adaptation. Stormwater issues are not included in the programme. Kaarina is located by the Archipelago Sea and the city strategy states the protection of the sea as one of the strategic goals. Kaarina has not made a separate stormwater programme or set any municipality -level guidelines for increasing water retention and green infrastructure in new planning areas.

3.5.2 The building code

The Kaarina city building code (Kaarina 2017) states that stormwater must be treated by retention or infiltration on site where it is possible. Where this is not possible, it must be led to open conduction systems (ditches) or public stormwater sewer, where it is available. One third of the unconstructed lot area must be left uncovered or it must be covered with permeable surface materials.

3.5.3 Blue-Green factor and Stormwater detention regulation

Kaarina city uses an own calculation tool, which is called stormwater calculation factor tool. In the detailed plans of some new planning areas there is a provision stating that stormwater in private properties must be handled according to separate stormwater management instructions in the area-specific building instructions. The instructions include an information part explaining why and how stormwater should be managed in private lots. The instructions then present the Kaarina stormwater calculation tool and sets requirement for minimum points from the calculation. The calculation tool calculates the number of points based on areas of impermeable, semi-permeable and permeable surfaces, lawns and planting areas as well as green roofs. Extra points can be earned from saving natural vegetation, from stormwater retention or filtration structures and from conducting roof runoff to vegetated areas. This tool differs from other in that it does not consider biodiversity, only the permeability and stormwater retention, detention or reuse. The tool and the related instructions have been used in several planning areas starting from 2018, but recently their use seems to have diminished. A planner that had recently started working in Kaarina was not aware that Kaarina has an own stormwater calculation tool or any practices for requiring stormwater regulation at private properties. The calculation tool is not available on the Kaarina web pages, it is only distributed to the constructors when the possession of the lot is handed over to the new landowner.

3.5.4 Stormwater funding and fees

No stormwater fee is collected.

4 Impact analysis

The main aims the cities have named for the use of the blue-green factor tool and the stormwater retention requirements are to increase the stormwater detention, retention, infiltration and reuse and the urban green as these both are essential for increasing the climate resilience of a city. In this study, we wanted to collect data and expert views on how effective these regulations are in increasing the urban green and use of water retention or detention structures. The building permit data collection covered only the Turku city, but the interviews covered experts from different cities.

4.1 Analysis of building permit documentation in Turku

To get numeric indicators of the outcomes of the use of blue-green factor target levels and Hule-100 rule for stormwater regulation in Turku we examined documentation that the property developers had submitted to the city when applying for building permits, particularly BGF calculation sheets, garden plans and stormwater plans. This information is classified as public, but in practice the documents are stored in an information system of Turku city, so they can only be accessed through a specific request to the city building inspection department. We requested documentation for all areas where blue-green factor had been used and initially got documentation for over 60 properties. Of those, 39 plans from urban construction sites near Turku center (Figure 3) were selected for further study, based on availability of sufficient documentation on green infrastructure and stormwater solutions. All these documents were from building permits applied during 2021-2022 and only part of the lots have been constructed to date.

For each case, the surface area of buildings, impermeable surface area, green surface area, the BGF score and the type of stormwater management solutions were gathered onto an excel sheet that was used for analysis of the data. Upon examination of the documentation, it turned out that there were many discrepancies between the BGF calculations and the actual garden plans or stormwater plans. This was at least partly due to different interpretations of the definitions in the calculation sheet. To ensure consistency in the data interpretation, we used the surfaces in the BGF calculation sheet, as garden plans or stormwater plans were missing in some cases.

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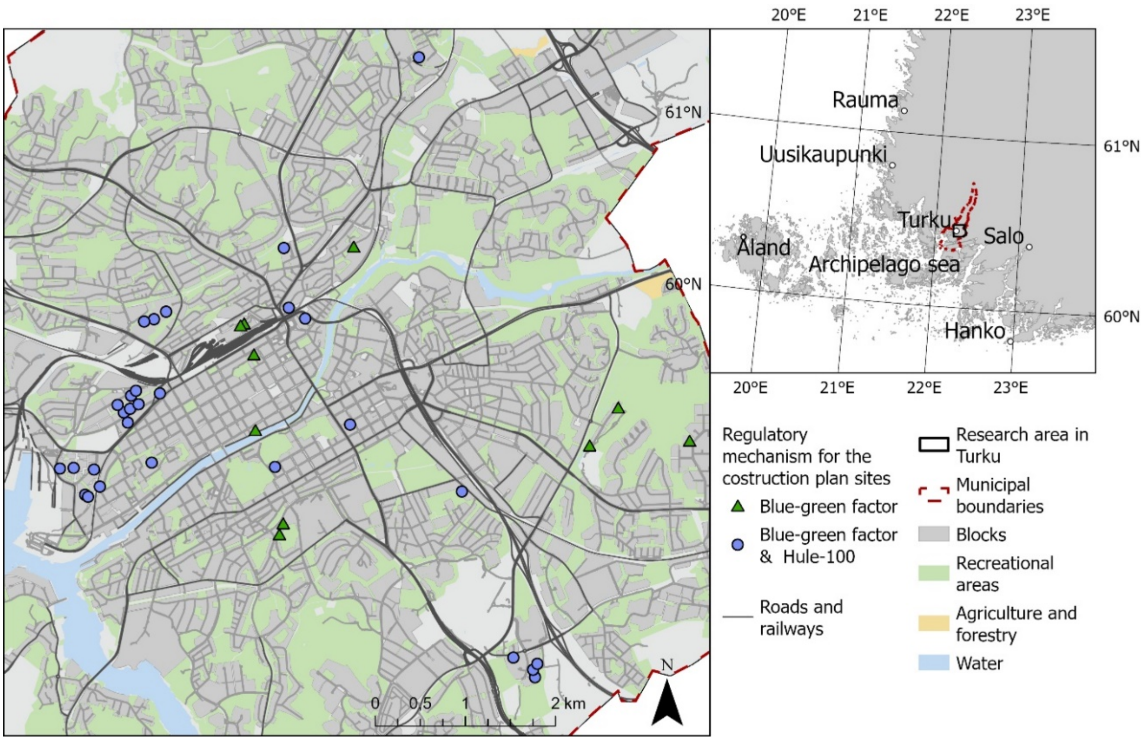

Figure 3 Location of the lots included in the study. Data sources: the National land survey of Finland, Finnish Transport Infrastructure Agency's and City of Turku.

4.1.1 The stormwater detention solutions in the plans

The percentage of the total lot area covered by buildings (Figure 4) and the percentage of the total lot area covered by impervious surface (Figure 5) were calculated for each study lot. The area covered by the buildings vary between 10 and 98% and the proportion of the impervious surfaces in the study lots vary between 29 and 97 %. The surface area of the green roofs is included in the permeable surfaces, as in the BGF calculation tool it is excluded from the impervious surface area calculation.

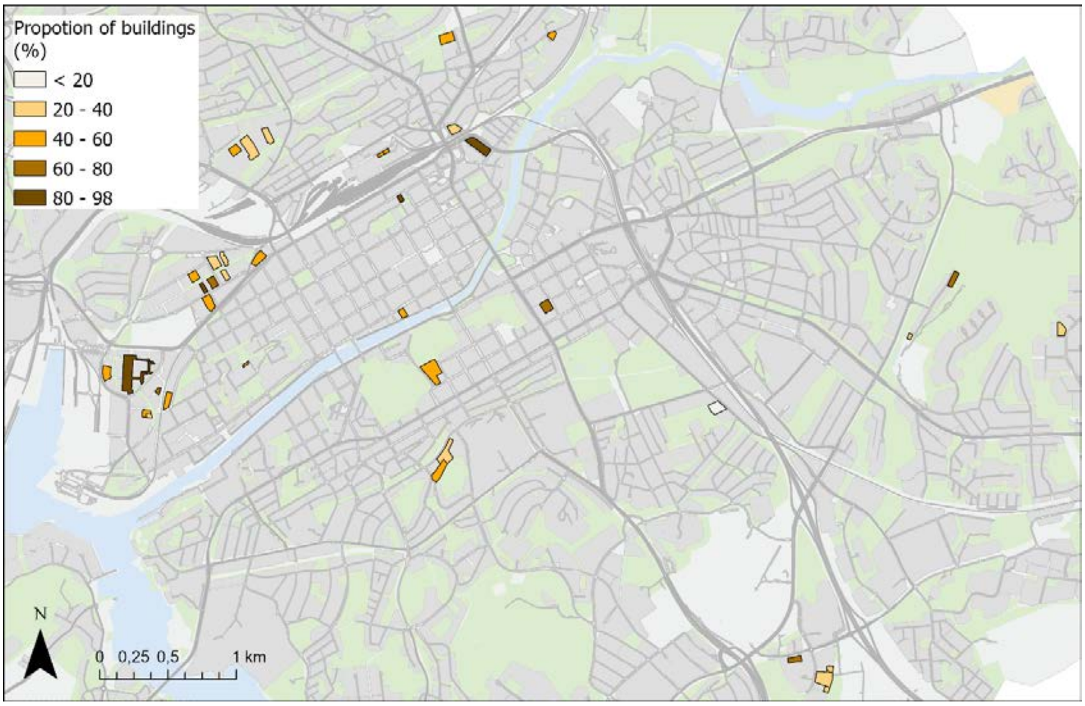

Figure 4 Building area out of the total lot area (%)

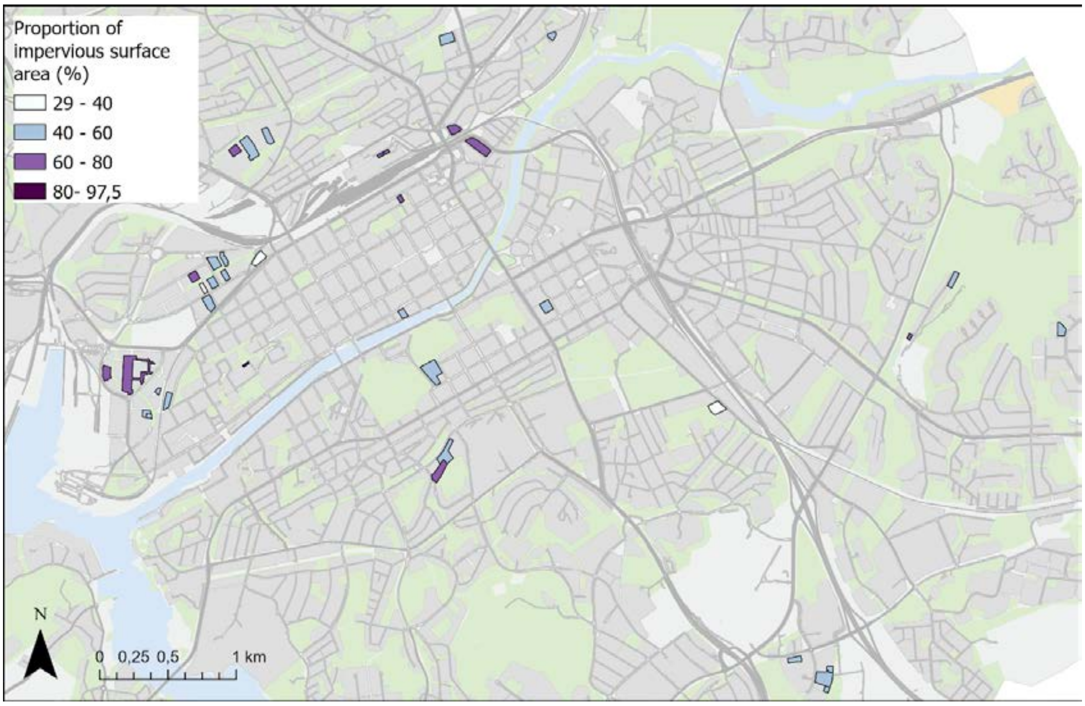

Figure 5 The share of the impervious surfaces out of the total area of the lots.

The stormwater detention requirement was derived from the BGF calculation sheet as $1m^3$ of detention space per $100m^2$ of impermeable surface. All studied lots presented plans for at least minimum required detention and except in one case, it was mainly accomplished by using grey solutions. In 56% of the studied cases there were underground large detention pipes, 28% had underground storage tanks or cassettes and 15% of the lots had a stone-covered retention structure (above the surface). Natural, ground-based nature-based stormwater retention structures, such as rain gardens or green swales, had been used only in 13% of studied lots and 62% had green roofs. It is notable, that almost half of the green roofs were semi-intensive or intensive green roofs. Until now, there has been very few green roofs in Turku and they have been almost without exception extensive sedum mat roofs.
All studied properties were located in areas of relatively high building efficiency ratios (inhabitants/m^2 of lot surface), thus the availability of surface was an obvious limiting factor for using green infrastructure, as there are many other functions competing of the limited free space, such as waste recycling facilities, bike parking and playgrounds. Typically, the car parking is placed underground, which means that an important part of the yard is placed on the top of an underground parking, which sets further limits for installation of NBS and planting of bigger trees. In some cases, several lots had been combined to one BGF calculation, which gave flexibility to the placing of different buildings and functions within the bigger area and in one case allowed leaving sufficient place for a larger stormwater retention pond. In some plans also the clay soil was mentioned as a reason for using grey solutions for stormwater detention rather than nature-based infiltration structures.

4.1.2 The area and the quality of green surface

The green surface coverage in the studied lots varied between 2 and 60 % (Figure 6). There was a wide variety between the coverage of the green surface but also between the ambition level of the quality of green areas. In some lots there was just lawn and some conventional non-native garden plants, whereas in some lots there was a good selection of biodiversity-promoting green solutions, such as intensive green roofs, pollinator meadows and local trees and other plant species. Thus far, these solutions have not been applied much in new developments. While it is obvious that the use of BGF requirements has not led to the improvement of the quality of urban green in all cases, it has certainly increased the number of lots where biodiversity has been considered. At this point it is too early to assess the real impact of these solutions as many of the lots have not been built yet and the plants have not had time to develop yet. Also, the maintenance of the green solutions will be a key factor affecting their impact.

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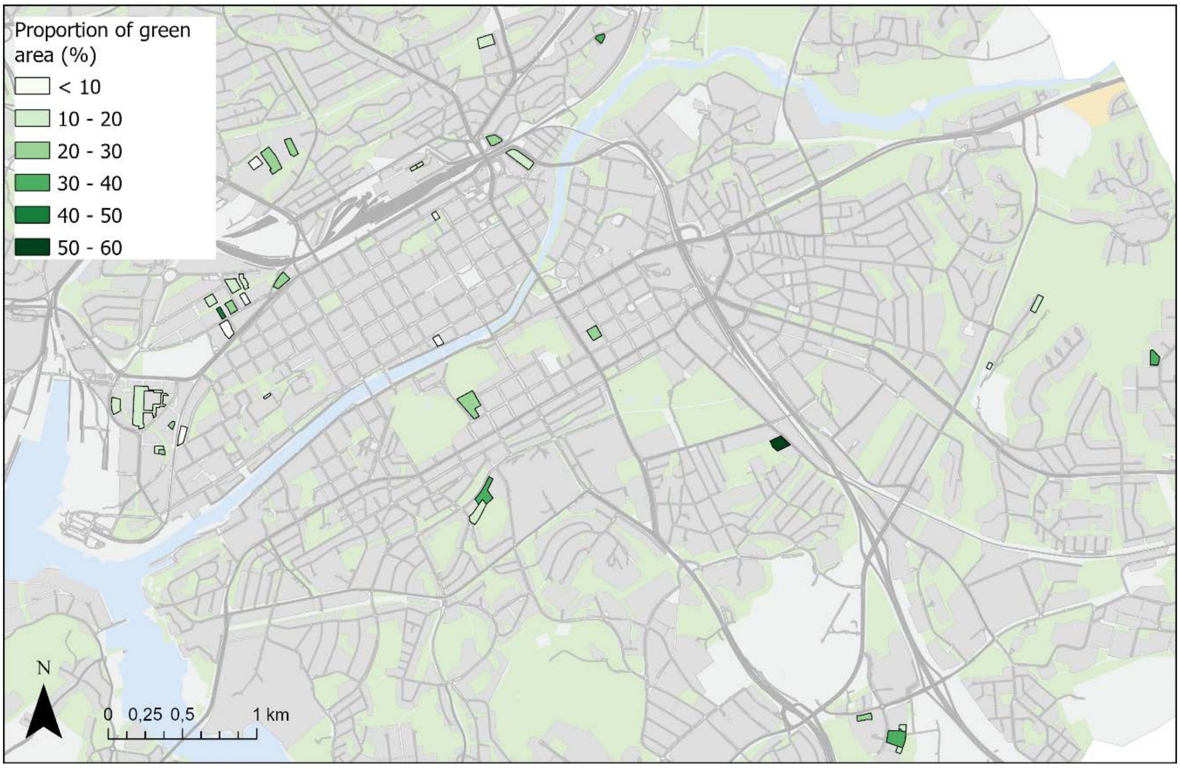

Figure 6 Percentage of green area in the lots

4.2 Expert views on the bottlenecks for increasing NBS and Best Practices

To get insight into the practical implementation of the BGF and different stormwater regulations seven interviews were conducted with (anonymous) experts from different municipalities, representing three different groups:

- Building inspectors who work with land use plans in city administration.
- Zoning planners responsible for the development of land use plans within municipal administrations.
- Planners who work with the building companies and who have to make plans according to the regulations

The interviewees were asked about their experiences and perceptions of the BGF and hule-100 regulations; how well they work, and how they should be developed. In addition, the interviewees were asked what are, in their opinion, the main bottlenecks for uptake of nature-based stormwater management solutions in urban areas ~~are~~. The questions are listed in Attachment 1.

All respondents agreed that the aims of increasing urban green infrastructure and water retention are good and important. However, all of them also pointed out a number of factors that lead to a gap between policy and aims and the practical implementation of NBS and water retention solutions.

4.2.1 Shortcomings of the BGF calculation tool and suggested improvements

The interviewees generally thought that the blue-green factor is a good tool for increasing city green. This is in line with an earlier study carried out in Helsinki (Helsinki 2021) where they had interviewed three landscape architects that had been using the tool in planning of new properties. However, many thought that the BGF target levels are too easy to reach with very basic solutions that do not bring significant benefits for the biodiversity or water management. Further, the tool was considered ineffective in increasing the use of nature-based stormwater solutions. This is in line with the outcomes of our inventory of building permit documentation (Chapter 3.1), where it turned out that despite the use of BGF, the water detention requirements had been met mainly using grey infrastructure, such as stormwater cassettes or large pipes. The same observation has been made elsewhere in Finland; the use of stormwater detention requirements in municipal planning, such as the Hule -100 rule, result mainly in grey underground stormwater detention solutions (non-published discussions). Thus, many thought that there could be stronger incentives for applying NBS, stormwater reuse and qualitative management solutions.

The main shortcomings and ideas for improvements that came up in the interviews can be grouped under two themes:

1. More explicit definitions of different measures and surfaces are needed. There is place for various interpretations in the calculation sheets, which in some cases even allows deliberate misinterpretations that allow reaching a higher score.
   - Use of indigenous species is rewarded in the calculation sheet, these should be defined and listed in the instructions of the tool. Helsinki has made an urban plant guide which could be used also in Turku and Kaarina, that are located at same latitude by the sea.
   - The trees of different sizes get different scores – the sheet should define which trees are considered large, middle sized or small.
   - In the calculation tool of some cities, it is possible to enter controversial values for different surfaces, e.g. so that reported surfaces do not cover the whole lot or that they add up to more than the total lot size. The Tampere BGF tool considers the calculation valid only when the surfaces match.

2. The tool does not take soil properties into account although these might have a significant effect on water detention volume and time. For instance, the soil porosity (amount of void spaces between solids) affects how much water can be stored in a given volume of soil, how quickly it passes through the soil (permeability), or how easily it can evaporate or be utilized by plants. In Turku, the BGF tool does not consider soil permeability at all. In Tampere and Helsinki lack of permeable soil reduces the BGF target levels by 0.2 but has no effect on the weighing factors of different retention methods. This approach ignores that, e.g. permeable pavements have little effect when being installed on an impermeable base, as the only storage volume is provided by the pavement itself. Once this volume is used, water needs to evaporate before more water can be detained. In contrast, a permeable constructed layer below the paver provides additional storage volume and conveys water to deeper layers, thus helping to restore the detention capacity in a predictable way. For NBS, the BGF tool only considers the surface water storage volume, e.g, depression storage, but not the subsurface storage volume provided by natural or constructed soils. It also ignores the importance of the soil for restoring the detention capacity of the NBS. Finally, also the detention capacity of green roofs is ignored. Including these in the water detention space calculations would provide a further incentive to use green roofs and NBS structures.

4.2.2 Bottlenecks and Best Practices at different levels of the implementation process

The two most important points, that were raised by all interviewees were that on the other hand there is a need for national guidelines, tools and regulations for stormwater management and on the other hand, the local conditions must be taken into account, when setting the requirements and selecting methods. These two are not controversial, if the national guidance is made so that it allows taking into account the characteristics and needs of different areas. Ideally, the stormwater regulations and choice of methods would rather depend on the local conditions, (such as erosion sensitivity and soil type, receiving network capacity and sensitivity of surrounding water bodies) than in which municipality the lot is located.

A number of observations, bottlenecks, best practices and development ideas that were raised during the interviews a presented in the Table 2. The Best Practices presented in the table are not an exhaustive list of good practices in Finnish cities, they should be considered as examples.

Table 2 Bottlenecks, Best Practices and Recommendations for implementation of climate sensitive stormwater management practices based on expert interviews

<table>
<tr><th colspan="2">Policy making</th></tr>
<tr><td>Bottlenecks
• Climate adaptation action plans are still often missing and/or they are not properly aligned with the biodiversity and climate mitigation strategies
• Consistent long-term implementation of stormwater regulations in municipal planning is not possible if the high level commitment and statements on stormwater management principles and requirements are missing
• The regulations for better water retention/detention and increase of green spaces are not enough linked to spatial and detailed climate vulnerability analysis, in spite of the potential of the zoning plans to adapt the rules the zone climate vulnerabilities
• The lack of binding force of the regulations - recommendations do not work, requirements are needed</td><td>Best Practices/ Recommendations
➢ The climate adaptation strategy of Helsinki city emphasizes the need for increasing resilience of the city during floods and draughts – this gives a strong basis for an ambitious stormwater programme
➢ All bigger cities have stormwater programmes accepted by the city council, where the principles of stormwater management have been laid down. This ensures continuity and facilitates communication between different actors.
➢ Adapt the spatial regulations to the spatialised context of the cities in terms of climate vulnerabilities to flood and provision of biodiverse green spaces. Tampere has developed an own version of the regulation, Hule -43, with a greater detention requirement is 1.1m^3 instead of 1.0 m^3/100m^2 impermeable space.
➢ After initial piloting phases all cities have taken a policy that the BGF target levels are binding.</td></tr>
<tr><th colspan="2">Use of BGF requirements in detailed area planning</th></tr>
<tr><td>Bottlenecks
- In many cities detached and semi detached houses are exempted from requirements and the BGF requirements are rarely used in industrial or logistics lots.</td><td>Best practices/ Recommendations
➢ The BGF requirements should be extended to industrial and logistics sites, as they are hot spots of stormwater management from both quality and quantity perspective and cover biggest share of new land-take area (EEA 2021)</td></tr>
</table>

<table>
<tr><td>
- Unclarity of the lot area where requirements have to be met in retrofitting cases – do they concern the whole lot or just the part that is being developed?
- The water detention requirements do not incentivize or impose use of nature-based solutions, thus grey solutions are applied
</td><td>
➢ Possibility to combine lots and use BGF targets for a bigger area has given in some cases in Turku and Helsinki flexibility to planning and allowed construction of a stormwater management solution of significant size.
➢ Tampere has introduced a stormwater regulation (Hule -51), that requires that a certain percentage of the required detention space has to be realized using rain gardens.
</td></tr>
<tr><td colspan="2">Lot planning by private companies and property owners</td></tr>
<tr><td>
Bottlenecks
• Lack of space and the prevalence of deck yards are limiting the use of NBS – more information and experiences are needed on nature-based stormwater solutions that can be fitted into densely built environments in Nordic climate
• Planners and construction companies are lacking know-how for planning and constructing NBS water retention solutions – stormwater planning is usually done by the HPAC engineers, that don't have expertise on NBS, whereas underground stormwater cassettes and large pipes are well known by planners and construction companies
• There is uncertainty about the actual costs, functionality and maintenance needs of the NBS, and a gap of awareness or calculation of the non-monetary benefits
</td><td>
Best Practices/ Recommendations
➢ Helsinki and Tampere have actively organized site visits for planners to forerunner properties with innovative use of green infrastructure.
➢ Lahti provides individual guidance for constructors and most cities have produced guidance for property developers and individual citizens. However, nation-wide practices in regulation and planning of stormwater systems would allow more cost efficient development of guidance and training
➢ It would be important to systematically collect and share information on these topics between cities.
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Building inspection/ monitoring of realizations	
Bottlenecks • The building inspection departments lack resources and on-site inspections are nonexistent or done too late – due to the lack of surveillance, the plans are not always realized as stated in the plans. • The building inspection officers lack expertise on NBS and stormwater retention solutions, they are often engineers, but have no expertise on plants and soil, and the ecological aspects of garden building. • Feedback about the functionality of provisions and regulations from the permitting and realization phase do not often reach the planners – lack of communication between different departments.	***Best Practices/Recommendations*** ➢ In bigger cities there is often a building inspector that is specialized in blue-green infrastructure and has expertise for assessing the garden plans and blue-green infrastructure. ➢ Regular communication between the planning department and building inspection department would allow organizational learning and development of the processes from planning to realization.

4.3 Financial implications of the regulations

Stormwater regulations cause additional expenses to different stakeholders, or they can transfer costs between different stakeholders, for example reduce public expenditure on stormwater systems at the cost of private landowners. On the other hand, they can also cause savings either directly or by enhancing ecosystem services. Rakli (the association of professional property owners) published a study about the costs of different zoning provisions to the property owners (Rakli 2021) and there the use of blue-green factor was calculated to result, for three pilot cases in Helsinki, in 4-10% savings of the total cost of the construction project. The saving came from the change of impermeable concrete or paved surfaces to permeable gravel or stone ash and from saving of the existing vegetation instead of planting new. It was noted that if green roofs had been used for reaching the BGF target, then the costs would have increased significantly.

Similar perspectives emerged in the expert interviews of our study. When asked about the costs, savings or benefits related to stormwater regulations, most of the respondents raised first the increased costs related to planning and construction of yards and stormwater systems. The uncertainty related to the actual costs, including maintenance, was also listed as one of the most important reasons for not implementing NBS. Further, many of the interviewed experts mentioned that the municipality would need to put more resources to the guiding of property developers and to the building inspection of stormwater systems to ensure compliance and all respondents representing municipalities estimated that these resources are currently insufficient. Some of the respondents noted that there might be savings in the construction of public stormwater systems, if private properties installed stormwater retention, detention and/or filtration structures. On the other hand, one respondent noted that in their municipality they cannot trust the stormwater retention systems in private properties, thus they do not consider the capacity of private systems when dimensioning the public ones. Only one of the interviewees mentioned that using blue-green factor may result in financial benefits through enhanced ecosystem services. This is line with earlier observations that benefits that are not easily monetized are usually not considered.

There are no up to date statistics on how many percentages of the Finnish municipalities are collecting stormwater fees, but studies carried out by Kuntaliitto (2019) and HAMK (2021) have reported that around 30-50% of the municipalities collect stormwater fees. The stormwater fees are used for funding the public stormwater management structures or other stormwater related services, such as producing information materials and advising citizens and companies. Typically, the fee is determined by the type of land use and the size of the lot. To the best of our knowledge, there are no cities in Finland where the use of NBS or other stormwater management structures would affect the stormwater fee. From the cities investigated in this benchmarking study, Tampere and Helsinki have had the stormwater fee in use for several years. Turku, Kaarina and Lahti do not collect stormwater fees and in these municipalities the stormwater management is funded from the municipal budget.

4.4 Social acceptance of the regulations

The social impacts of increasing uptake of NBS have been reviewed and discussed recently in a number of publications e.g., the Unalab project (Hawxwell 2018) and a special issue of Environmental Science and Policy (March 2023). A thorough analysis of social impacts of stormwater regulations was not in the scope of this benchmarking analysis. However, questions about reactions of citizens and politicians to the introduction of stormwater management requirements were included in the interviews and the responses give an indication of how the regulations have been received by the citizens and what kind of social aspects the municipal authorities have to deal with when applying stormwater regulations.

Based on our expert interviews, in each of those municipalities that had taken in to use the stormwater fees there have been complaints from individual citizens, as is often the case upon the introduction of any new fees. In Turku these complaints led to the abolishment of the fee only two years after its introduction. In Helsinki and Tampere, the fee had become a normal practice after the initiation period. The introduction of new stormwater regulations followed the same pattern; after initial complaints they had been accepted as the new normal. However, individual citizens who build a house for themselves, often complain that the regulations are unjust, as their neighbor who built the house many years ago did not need to install any stormwater retention or detention structures. During the interviews it turned out that in some cases the stormwater regulations would have caused unreasonable costs to the property owner (e.g., the stormwater detention structure should have been quarried into the bedrock) and in those cases several interviewed municipal authorities said that exceptions had been given. It was noted by many of the interviewees that while it is important to treat all property owners equally, it is also important to reserve the right to admit exceptions in some cases.

The interviewees were not aware of the political discussion related to the decisions about application of stormwater regulations, except for one person who had been involved in the presentation of the topic to the city council. In Turku there had been a political debate about the introduction of the blue-green factor and how binding the target levels should be (Turku 2020). As a result, the decision about the application of the BGF target levels in new urban plans was postponed and a public consultation of the proposed regulation was organized. An invitation to participate and comment was sent to 41 expert organizations and it was publicized in a citizen participation platform (Kerro kantasi -service) for one month. Eleven expert organization submitted comments, mainly related to cost implications, exceptions and the ambition level of the regulations but there were no comments from individual citizens (Turku 2021b). This can imply that citizens do not see stormwater regulation as something that would concern them or that they feel they do not have enough expertise to express an opinion. As a result of the hearing, the city government decided, in its meeting on 1st February 2021, that the blue-green factor target levels should be considered as recommendations in all new development plans, when the initial proposition had been that the target levels should be considered as binding (Turku 2021c). However, in March 2021 Turku city development office published the new building code which stated that the blue-green factor target levels are binding (Turku 2021a).

5 Conclusion

In this report we presented results from a benchmarking study of stormwater regulations that are used in municipalities to motivate private property owners to apply NBS and sustainable stormwater management measures. The aim was to document the policy and practice of stormwater regulations in different municipalities and to find out how different approaches work in practice. In addition to analyzing documents related to policy and regulations, we interviewed local experts who are dealing with stormwater regulations in their daily work as municipal planners, building inspectors or planners in private companies. Further, in Turku we analyzed building permit documentation from 39 different properties to see what kinds of solutions the property developers are planning to use to comply with the regulations.

The main observation from the benchmarking of regulations and policies is that each municipality is developing their own regulations and policies and that there is a clear need for national level guidelines. This need was also expressed by all interviewed experts. Currently the variability of regulations cause confusion, hinders building of know-how of property developers, and a large potential for synergy in joint development is being lost. It also became evident that local site characteristics, such as the ecological sensitivity of the discharge site, the planned land use and the soil permeability, must be considered when setting stormwater management requirements. Thus, the national level regulations should include options and guidance for adapting them to different conditions.

Both from the expert interviews and the study of building permit documentation it became clear that in many cases it is still relatively easy to get the building permit accepted by presenting plans with just lawn, some conventional decorative plants and underground stormwater detention tanks. While an increasing number of developers now present yard plans with a diverse set of biodiversity friendly green solutions, they still resort to underground grey infrastructure for water detention. which is well known by the planners and investors. Only very few property developers or landowners plan for nature-based stormwater solutions. Mainstreaming the uptake of NBS for stormwater detention and retention would still need innovative development of regulations and incentives, and raising of awareness of different stakeholders, including property developers, plumbing engineers, yard planners and building inspectors.

This work serves as a basis for future studies and development within RESIST project both at regional and international levels. At the international level, the regulations will be compared between the twinning regions Normandy and Eastern Macedonia and Thrace as well as other interested regions within the project. The aim is to search for successful and functional regulations and incentives that could be transferred to other regions and share best practices.

In SW Finland the regulation study will be continued by visiting some of the lots to evaluate how the plans presented at the building permitting phase are translated into practice. Further experts from building inspection, construction companies and maintenance of the green infrastructure will be interviewed, suggestions for regulation development, and a plan for awareness raising will be drafted. Finally, the results of this study will be communicated to the expert community at the national level and used for lobbying for the development of national guidelines for regulation.

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7 Attachments

7.1 Attachment 1

Interview questions (Translated from Finnish to English):

Questions for Planners working in consulting companies.

- Do you think the blue-green factor and the related calculation tool were a working regulatory tool? What has been functional and good about the tool? What has not worked and what are the challenges involved?
- Do you think the Hule-100 were a working regulatory tool? What is workable and good? What has not worked and what are the challenges involved?
- Does the use of the blue-green factor cause additional costs or savings in the construction of the property? What are these costs made up of? And same question about the use of hule-100?
- Do you think the blue-green factor or hule-100 regulation should be developed? If so, how?
- What do you think, why there are less nature-based stormwater solutions implemented compared to technical solutions?
- Do you know any other regulatory measures related to the qualitative or quantitative management of stormwater?

Questions for building inspectors

- Do you think the blue-green factor and the related calculation tool were a working regulatory tool? What has been functional and good about the tool? What has not worked and what are the challenges involved?
- Do you think the Hule-100 were a working regulatory tool? What is workable and good? What has not worked and what are the challenges involved?
- Does the use of the blue-green factor cause additional cost or savings to the city? What are these costs made up of? And same question about hule-100?
- Have there been any complaints about the blue-green factor or the hule-100 regulatory? What have these complaints been about and from whom have they come?
- Do you think the blue-green factor or hule-100 regulation should be developed? If so, how?
- Is the implementation of regulatory instruments supervised? If so, how? At what point in the process?
- What do you think, why there are less nature-based stormwater solutions implemented compared to technical solutions?

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Questions for zoning planners

- Do you think the blue-green factor and the related calculation tool were a working regulatory tool? What has been functional and good about the tool? What has not worked and what are the challenges involved?
- Do you think the Hule-100 were a working regulatory tool? What is workable and good? What has not worked and what are the challenges involved?
- How has the blue-green factor been developed during its use? How about the hule-100 regulatory?
- Should those be further developed? If so, how?
- Do you use any other regulatory measures related to the qualitative or quantitative management of stormwater?
- Does the use of the regulatory cause additional cost or savings to the city? What are these costs made up for?
- Is the implementation of regulatory instruments supervised? If so, how? At what point in the process?
- What do you think, why there are less nature-based stormwater solutions implemented compared to technical solutions?

7.2 Attachment 2

The blue-green factor example from city of Turku

TURKU

TULOSKORTTI

Sivu 1/2

Päiväys	20.11.2023		
Kaupunginosa/kylä	10	**Lupanumero**	xxxx.xxxxxx
Kortteli ja tontti		**Hakijan nimi**	Regulation studies
Rakennuspaikka	10	**Jakeluosoite**	0
Tontin osoite	Testikatu 102	**Sähköpostiosoite**	0

Tontin ala	2 450m2	**Rakennusten peittopinta-ala**	1 200m2

	Vaadittu	**Saavutettu**
Viherkerroin	0,80	0,837
Läpäisevä pinta-ala tontilla	20,00 %	41,22 %
	490,00 m^2	1 010,00 m^2
Hulevesiratkaisujen viivytystilavuus m^3	14,30	16,3

Huomiot:

- Tarkista, vaaditaanko tontilla läpäisevän pinta-alan vähimmäisosuus.

Hulevesien hallintarakenteet:

5 m^3 - Kivipintainen hallintarakenne (viivytyskuoppa, kivipesä tai suodatuskaista, tehollinen varastointitilavuus)
7,3 m^3 - Kasvipintainen hallintarakenne (sadepuutarha, biosuodatus tai viivytysrakenne, tehollinen varastointitilavuus). Merkitse kasvillisuus erikseen.
4 m^3 - Viivytyskaivanto, -kasetti tai -säiliö (maanalainen, varastointitilavuus)
10 m^2 - Lampi tai vesiaihe (ainakin osan vuodesta pysyvä vesipinta)

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TURKU

HUOM! Siniviherkertoimen laskelma ei korvaa hulevesiasiantuntijan tekemää hulevesisuunnitelmaa.

Sivu 2/2

Kaupunginosa/kylä	10	**Päiväys**	20.11.2023
Kortteli ja tontti		**Lupanumero**	xxxx.xxxxxx
Rakennuspaikka	10	**Tontin osoite**	Testikatu 102

Tontin ala	2 450m2	**Rakennusten peittopinta-ala**	1 200m2

Säilytettävä kasvillisuus ja maaperä:

3 kpl - Säilytettävä hyväkuntoinen isokokoinen puu (täysikasvuisena > 10 m), korkeus vähintään 3 m (à 25 m²)
2 kpl - Säilytettävä hyväkuntoinen pienikokoinen puu (täysikasvuisena ≤ 10 m), korkeus vähintään 3 m (à 15 m²)

Istutettava / kylvettävä kasvillisuus:

3 kpl - Isokokoinen puu, täysikasvuisena > 10 m (à 25 m²)
4 kpl - Pienikokoinen puu, täysikasvuisena ≤ 10 m (à 15 m²)
12 kpl - Isot pensaat (à 3 m²)
10 m² - Perennat
800 m² - Nurmikko
200 m² - Niitty-, keto- tai heinäkatto eli ohutrakenteinen, puoli-intensiivinen viherkatto. Kasvualustan paksuus 15 – 30 cm
102 m² - Viherseinä, vertikaalinen pinta-ala

Pinnoitteet:

Läpäisemätön pinta:

1430 m² - Läpäisemätön pinta-ala. Taulukko laskee tämän automaattisesti.

Bonukset:

14 m² - Hulevesien kerääminen läpäisemättömiltä pinnoilta kasteluvedeksi tai ohjaaminen hallitusti läpäisevälle kasvillisuudelle maassa.
12 kpl - Viljelyyn soveltuvat istutukset: hedelmäpuut (à 10 m²) tai marjapensaat (à 3 m²)
28 m² - Alueella luontaisesti esiintyvät lajit- väh. 5 lajia/100 m²
2 kpl - Luonnon monimuotoisuutta ja/tai eläimistön elinolosuhteita tukevat elementit, kuten lahopuu tai kannot, hyönteishotelli, lepakkopönttö tai siilin talvipesä

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