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Regional and national policy recommendations for implementing the integrated stormwater management in the Baltic Sea Region

BSR WATER – Platform on Integrated Water Cooperation
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Imprint

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Project note

The EU co-funded project **BSR WATER – Platform on Integrated Water Cooperation** (2018–2021; www.bsrwater.eu) aims to enhance cross-sectoral cooperation in smart water management by providing a possibility for transnational experience exchange, sharing of good practices and solutions, as well as delivering comprehensive overview of the current and future regional policy. The platform brings together experts representing diverse projects that have generated through transnational cooperation many replicable as well as unique solutions, covering broad variety of water-related issues.

The platform cooperation is based on practical achievements and results of seven projects addressing a wide range of water management challenges. The outcomes and practical findings of the contributing projects (IWAMA, BEST, iWater, Manure Standards, Village Waters, Reviving Baltic Resilience, CliPLivE) support the long-term development of regional environmental policy and recommendations, which will further strengthen the policy-practice link in implementation of advanced water protection measures, including smart nutrient management and sludge handling, storm water management and the energy efficiency cycle at the national and municipal levels.

Table of Contents

1. Introduction 4

1. Stormwater regulations in the Baltic Sea Region 6

2. Analysis of local stormwater management governance and practices 8

2.1. General information on the respondents 8

2.2. Baseline: existing stormwater management system 9

2.3. Organisation of the stormwater management and the integrated stormwater management 13

2.4. Stormwater quality 15

2.5. Survey results summary 18

3. Recommendations for implementing ISWM at the EU, BSR, national and local level 19

3.1. Drivers for sustainable urban stormwater management 19

3.2. Recommended measures and policy instruments to facilitate integrated stormwater management 20

3.3. Implementation of different aspects of ISWM 21

3.3.1. European Union level 21

3.3.2. Baltic Sea Region level 22

3.3.3. National level 23

3.3.4. Local level 24

Annex 1 Stormwater management legislation 25

EU level legislation 25

National, regional and local level legislation and guidance documents 26

Denmark 26

Estonia 27

Finland 29

Germany 33

Latvia 35

Lithuania 37

Poland 38

Sweden 42

Norway 43

Russia 44

Annex 2. Implementation of different aspects of ISWM at national, regional and local level and generic recommendations for including these aspects 47

Annex 3. Examples of local actions plans and programmes for sustainable stormwater management 54

City of Helsinki Stormwater Management Programme 54
The City of Copenhagen Cloudburst Management Plan 2012 57
Stockholm Stormwater Strategy 60
Växjö Climate Change Adaptation Plan 2013 62

GLOSSARY

BAT	Best Available Technologies
BS	EU Biodiversity Strategy for 2030
BSR	Baltic Sea Region
EQS	Environment Quality Standards
EUSBSR	EU Strategy for The Baltic Sea Region
FD	EU Floods Directive 2007/60/EC
FRMP	Flood Risk Management Plan
GAF	Green Area Factor
HA	Horizontal Actions
HELCOM	Baltic Marine Environment Protection Commission (Helsinki Commission)
ISWM	Integrated Stormwater Management
LID	Low Impact Development
NWRM	Natural Water Retention Measures
PA	Priority Areas
PAH	Polycyclic Aromatic Hydrocarbons (Oil Products)
RBMP	River Basin Management Plan
SUDS	Sustainable Urban Drainage Systems
UWD	EU Urban Wastewater Directive 91/271/EEC
WFD	EU Water Framework Directive 2000/60/EC
WWTP	Wastewater Treatment Plant

1. Introduction

Due to the climate change Baltic Sea Region (BSR) is facing more frequent and heavier rainfalls, most heavily affecting densely built and inhabited urban areas. Therefore, cities are in emerging need to deal with the common challenge of stormwater flooding – a challenge that may lead to environmental degradation, infrastructure damage, risks to human safety and other adverse impacts to urban environment. Such challenge is not easily answered as it requires a holistic, comprehensive, and knowledge-based approach to stormwater management.

Therefore, the concept of the **Integrated Stormwater Management (ISWM)** has emerged. According to the ISWM guidelines, developed within the iWater project[1], contrary to conventional stormwater management practices, the ISWM is a comprehensive approach to stormwater management. Instead of a narrow focus on a single problem, the ISWM undertakes a holistic stormwater management approach: studying the characteristics of specific sites and areas, understanding the relevant impacts, and tailoring a comprehensive array of tools to individual situations. Success requires the integration of the ISWM system into the urban development processes of the city at all levels, from urban planning to operation and maintenance.

With an ISWM system a city can:

- achieve their goals of water quality protection and flood mitigation to protect the natural and built environment,
- design for not just the worst-case scenario, but also for average and minimal events to minimize the impact of stormwater on neighbouring lands,
- determine what solutions and infrastructure together with their interconnections are required to manage the stormwater runoff that results from different storm events, and
- ensure that stormwater is treated as a resource that enhances our cities, rather than treat it as waste that needs to be removed through underground storm sewers.

Besides, the ISWM approach has a number of added advantages compared to conventional stormwater drainage. It enhances urban environment by applying greener and more eco-efficient planning principles, thus promoting additional environmental benefits and multiple ecosystem services. Further, the ISWM approach promotes transition from conventional to sustainable stormwater drainage where the priority is given to the “Green Infrastructures” over the “Gray Infrastructures”.

With the aim to better understand the baseline and other pre-conditions for setting up integrated stormwater management in the BSR, from September 2019 until March 2020 a comprehensive survey on stormwater-related legislation was carried out in all ten BSR countries, eight EU Member States – Denmark, Estonia, Finland, Germany Latvia, Lithuania, Poland and Sweden, and two partner

[1] iWater project – City of Turku, Environmental Division. Integrated Stormwater Management System Guidelines, iWater project website, www.integratedstormwater.eu/sites/www.integratedstormwater.eu/files/iswm_guidelines_2.pdf

countries – Norway and Russia. In parallel, structured interviews were carried out in 25 medium and large-sized cities of the BSR, assessing their current progress with introduction of sustainable and integrated urban stormwater management governance and practices, implemented improvements, as well as needs and future development prospects.

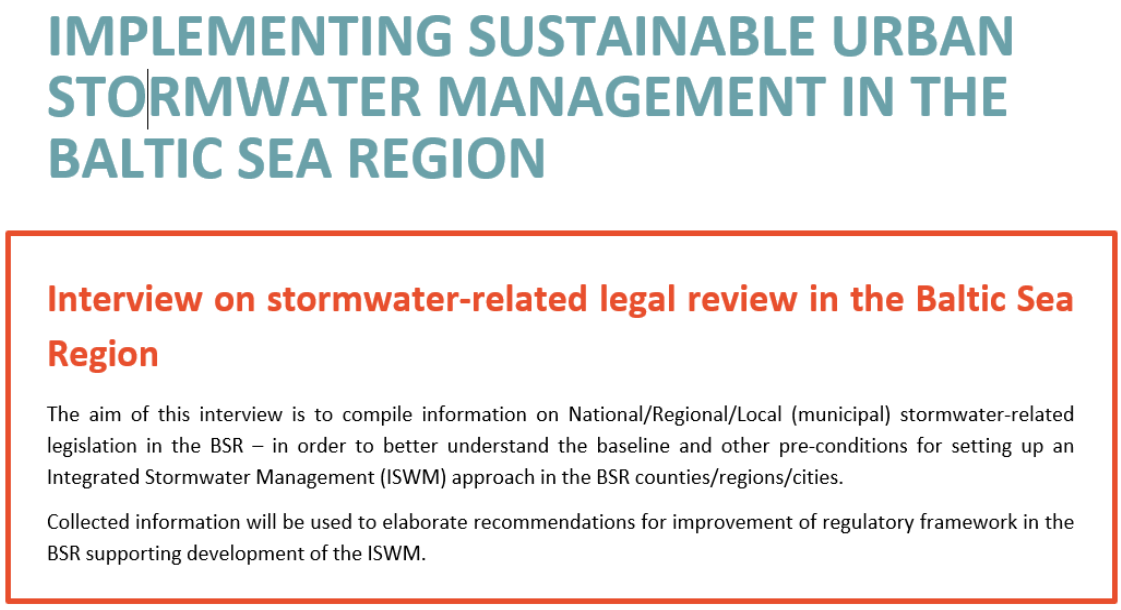
Both surveys were carried out as part of the BSR WATER platform project[2] where one of strategic goals is related to improvement of policy tools, in order to enable the BSR cities to implement sustainable and integrated stormwater management.

Present regional and national policy recommendations for implementing sustainable and integrated stormwater management in the BSR are elaborated on the basis of accumulated knowledge and practices of those forerunner BSR cities that have already obtained experience, understanding and practical skills within the field of natural, holistic and sustainable urban stormwater management.

[2] Interreg BSR programme 2014-2020 project #C001 “Platform on Integrated Water Cooperation” (BSR WATER), **www.bsrwater.eu**

1. Stormwater regulations in the Baltic Sea Region

This section is based on a survey on stormwater-related legal review, carried out in ten BSR countries. The cities have indicated the set of directives and guidelines influencing their activities in the stormwater-related field on the EU, national, regional, and local level (see the cover sheet of the questionnaire in the picture below).


IMPLEMENTING SUSTAINABLE URBAN STORMWATER MANAGEMENT IN THE BALTIC SEA REGION

Interview on stormwater-related legal review in the Baltic Sea Region

The aim of this interview is to compile information on National/Regional/Local (municipal) stormwater-related legislation in the BSR – in order to better understand the baseline and other pre-conditions for setting up an Integrated Stormwater Management (ISWM) approach in the BSR counties/regions/cities.

Collected information will be used to elaborate recommendations for improvement of regulatory framework in the BSR supporting development of the ISWM.

Figure 1. Legal review questionnaire cover sheet.

Below the main conclusions of the legal review are provided. The detailed summary of the legislation on EU, national and local level of BSR countries can be found in Annex 1.

In all BSR countries national level regulations sets principles and tasks of stormwater management, as well as defines the objectives of flooding prevention and ensuring water quality. However, the level of detail differs on these matters, specifically regarding the degree of setting some restrictions on the national level, as analysed in these documents.

Principles and priorities of sustainable stormwater management (e.g., runoff reduction, decentralised management etc.) are included in national legislation in some countries, for example Finland, Sweden, Poland, Lithuania, Germany and are not in other – Russia, Latvia, Estonia, Denmark, Norway. However, it does not preclude Danish cities like Copenhagen to be pioneers in implementing sustainable and integrated solutions. Sometimes (e.g., Norway) principles for sustainable stormwater management are not included in the legislation but national level guidelines are published promoting the same principles.

Stormwater-related legal review ascertained that in all BSR countries national legislation sets out quality requirements for wastewater treatment and monitoring, thus ensuring that the surface water bodies and groundwaters are kept in good condition. In some BSR countries limit values are set for pollutants in stormwater discharge to natural water bodies. In other countries, however, the general principle of stormwater treatment in the national regulations is included, if the stormwater may

cause damage to the environment, meaning that emission limit values may or may not be set in the environmental permitting process. In a few forerunning countries (e.g., Denmark, Germany, Sweden, Finland) national legislation provides detailed requirements/guidance for stormwater management.

Furthermore, the municipalities of Copenhagen, Berlin and Helsinki have adopted binding rules and guidelines for stormwater drainage and treatment, among other, prioritizing infiltration and retention of stormwater at the source, contrary to conventional practice to convey stormwater into wastewater or separate sewers, paying much attention to tackling extreme storm events and to mitigating the effects of climate change.

BSR cities that were interviewed on the issues related to introduction of sustainable stormwater management approaches and tools, highlighted the importance of this topic in the entire urban planning system – all interviewed cities admitted the need to introduce the ISWM system and adapt sustainable urban stormwater planning principles in the near future.

In most of BSR countries treatment and discharges of stormwater is regulated via integrated environmental permits. In some countries (e.g., Denmark, Lithuania, and Estonia) pollutant limit values for stormwater are explicitly included in the national legislation. In other countries (e.g., Finland), stormwater treatment depends on the condition of the stormwaters and receiving waters and no limit values are set and left to the local and environmental permit level. It is generally recognised, in accordance with the WFD, that the receiving water quality and status is the main benchmark for the needed degree of treatment in each specific case, which is reasonable yet requires detailed knowledge of the local conditions, which sometimes is not available due to the large size of the water bodies defined in the river basin management plans.

Some countries like Denmark explicitly state the procedure for preparing stormwater drainage basin plans and stormwater flood maps, some countries e.g., Finland and Latvia stipulate more generally stormwater flood assessment as a part of flood risk assessment in significant flood areas.

As a rule, forerunner countries (e.g., Denmark, Finland, and Sweden) have produced national level guidelines or standards for sustainable stormwater techniques.

ISWM and coordination of various stakeholders is regulated at the national level only in Finland and to some degree in Denmark.

2. Analysis of local stormwater management governance and practices

This section is based on a survey on sustainable urban stormwater management in the BSR cities. Structured interviews were carried out in 24 medium and large-sized cities of the BSR, assessing their current progress with introduction of sustainable urban stormwater management governance and practices, implemented improvements, as well as needs and future development prospects.

Figure 2. Cover sheet of the questionnaire on local stormwater management practices.

The analysis is split by the sections contained in the questionnaire.

2.1. General information on the respondents

The following municipalities contributed to filling out the questionnaire:

- Denmark: Aalborg, Copenhagen, Aarhus;
- Estonia: Tartu;
- Finland: Helsinki, Kuopio, Lahti, Turku;
- Germany: Rostock;
- Latvia: Daugavpils, Jelgava, Rīga, Liepāja;
- Lithuania: Kaunas;
- Poland: Elbląg, Gdansk;
- Sweden: Stockholm, Växjö;
- Russia: St. Petersburg, Kaliningrad, Chernyakhovsk, Zelenogradsk, Svetlogorsk, Pionersky;
- Belarus: Molodechno.

To summarise, 25 cities and towns have filled out the questionnaire**:** six from Russia (including five from the Kaliningrad oblast), four from Finland and Latvia, three from Denmark, two from Sweden and Poland and one from Germany, Estonia, Lithuania, and Belarus (see figure below).

Figure 3. Number of cities in each country of the Baltic Sea Region participating in the survey.

Median size of the participant city was 154 km^2 (range from 8.3 to 4326 km^2), median population 119 thousand people (range from 11 to 5384 thousand people). Median average annual precipitation 685 mm (range 539 – 911 mm), average annual temperature 7°C (range 3.5°C – 9°C). The respondent cities have mostly medium density of non-permeable/semi-permeable surfaces (between 25% and 50%). All but two cities (92%) have had stormwater-caused floods in last 10 years.

2.2. Baseline: existing stormwater management system

Climate change adaptation plans

More than a half (60%) of the cities have indicated having a climate change mitigation/adaptation plan, 40% have not. The pioneering cities like Copenhagen, Helsinki, Växjö or Gdansk have created comprehensive multi-sector plans looking at risks, impacts and measures across the entire spectrum, incl. stormwater, green infrastructure as an integral part.

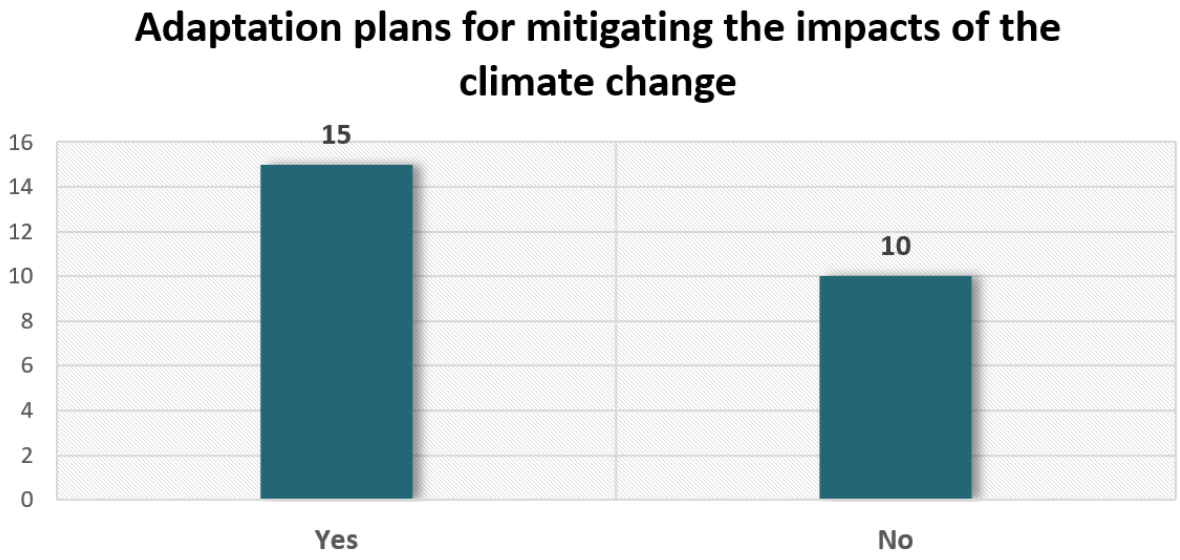


Figure 4. Climate change adaptation plans in the municipalities.

For example, Copenhagen has developed a climate change adaptation plan, having different levels of scale and level of integration. Helsinki has a wide range of planning documents, including Climate adaptation guidelines 2019-2025, Stormwater management programme as well as Flood strategy. In Sweden, Stockholm has developed an action programme on climate change adaptation, and Växjö – a comprehensive climate change adaptation plan and stormwater policy. Polish cities Gdansk and Elbląg have climate adaptation plans 2030, which are comprehensive plans including stormwater as one of topics.

Other cities have more sectorial and less comprehensive approaches. For example, Rīga has analysed both fluvial and pluvial flooding, however flood risk mitigation measures have been formulated for the fluvial flooding only. Likewise, Liepāja has a flood risk management plan dealing with fluvial flooding only. In turn, Tartu energy and climate action plan focuses on energy and transport, less on climate adaptation. St. Petersburg administration have declared having included climate adaptation into the city development strategy and water supply and sewerage planning documents, however no evidence of specific plans or actions relevant for sustainable stormwater management has been found.

Stormwater system type

Most cities (60%) have both combined and separated systems, 12% have only combined system, 28% have only separated system. Great majority (74%) of the cities having combined and partly separated system strive for completely separated system, 26% of the cities do not.

Sustainable stormwater solutions / green techniques (SUDS/LID)

Most cities (70%) indicated applying on-site SUDS (see figure below), however the sustainable techniques are not so widespread yet.

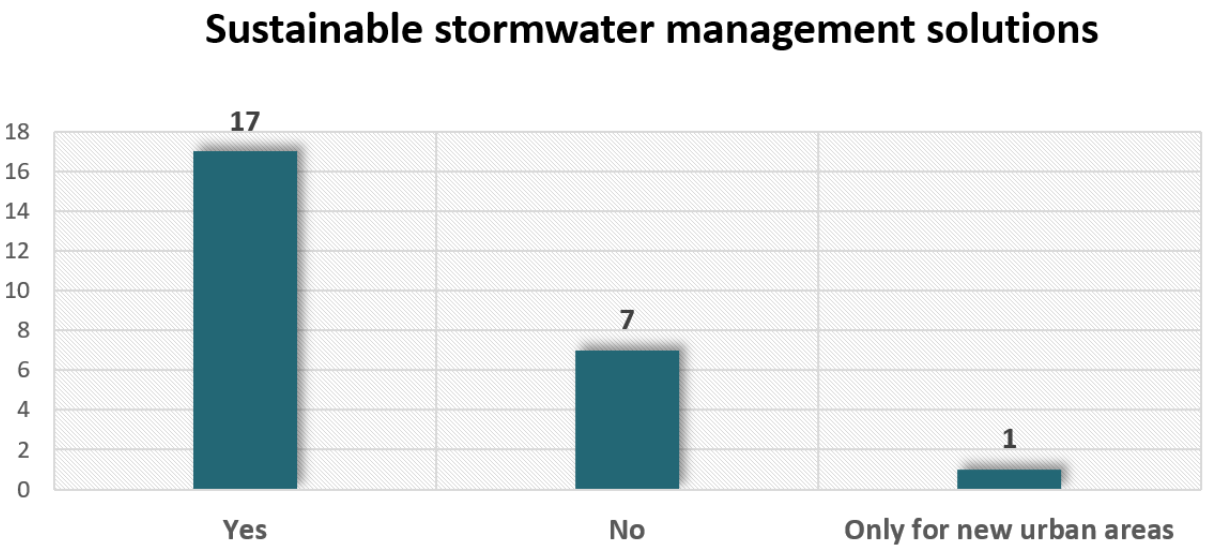


Figure 5. Number of municipalities that have and have not implemented SUDS.

44% of the cities have implemented between 1 and 5 applications during last 5 years, 18% have only first pilots. More widespread (6-20 applications) SUDS are in 18% of the cities and only three cities (18%) apply them on a widespread basis as a common practice.

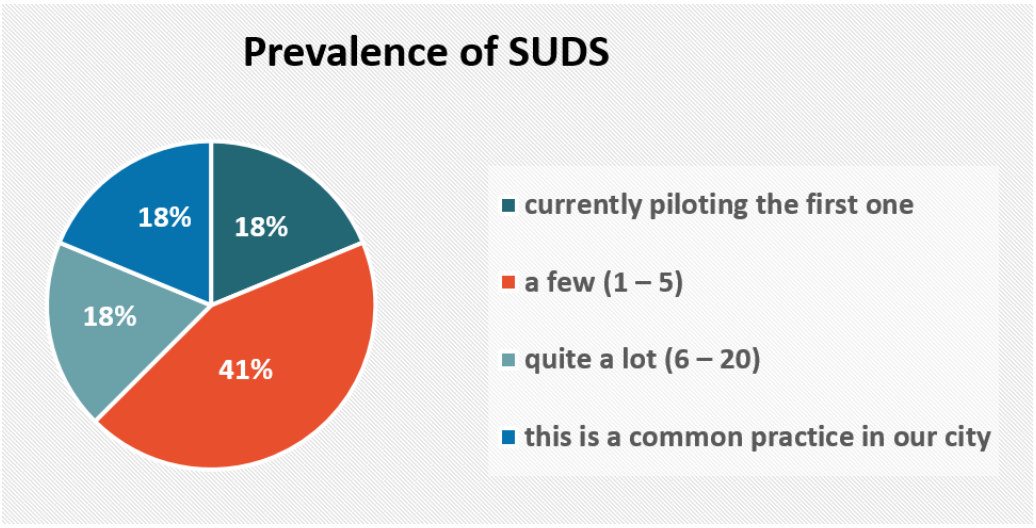


Figure 6. Prevalence of SUDS in the respondent cities that have implemented those.

48% of the municipalities have implemented SUDS purposely for improvement of stormwater quality in the city.

Stormwater sewer design for extreme events

Concerning stormwater sewer design, 36% of the cities indicated sewers being designed for extreme event in all (12%) or newly developed areas (24% of the cities). For those cities designing sewers for extreme events, most typical return period of the design event is 10 years (44%), and in 2 cases (22%) – 25 years. Differences exist on the exact technical specification of the return period: gravity flow vs pressurised flow. Also, a remark has been expressed about densely built areas, where sewers are being dimensioned for extreme rain events because it is difficult to provide space for SUDS.

Stormwater treatment

32% of the cities have indicated treating separately contaminated stormwaters led to the wastewater treatment plant (WWTP), e.g., from industrial areas, streets, etc., 48% have indicated not doing so and 20% indicated other answer. Other answers included treatment of stormwater in combined sewers, treatment of stormwater from industrial areas at WWTP, stormwater pre-treatment in oil setting tanks and separators before discharge to the receiving waters, partial (first flush) stormwater treatment at dedicated stormwater WWTP.

Stormwater regulations and payment for stormwater discharges

Majority (64%) of the cities indicated presence of municipal regulations guiding concerning stormwater management of some kind. They, however, differ in scope, ranging from stormwater treatment requirements for specific areas in local planning documents to guidance documents or formal regulation. Similar number (60%) of cities have implemented stormwater fee, which can be a connection fee (e.g., Aalborg, Copenhagen, Helsinki, Stockholm), a fee per m^3 of discharge to combined sewer (e.g., Liepāja, Daugavpils, Rīga, St. Petersburg), a fee per m^3 of discharge to separate sewer (e.g., Kaunas, St. Petersburg), a variable annual fee per m^2 of surface area, which may be differentiated by the type of property (e.g., Elbląg, Helsinki, Kuopio, Lahti, Stockholm), fixed annual fee per type and size of property (e.g., Stockholm, Turku). Some cities apply fee discounts for disconnection from the city's stormwater management system or SUDS on site (e.g., Stockholm), some cities do not (e.g., Turku), which depends on the city specifics – e.g., in Turku it is acknowledged that infiltrating water need to be taken care of by the city's drainage ditches.

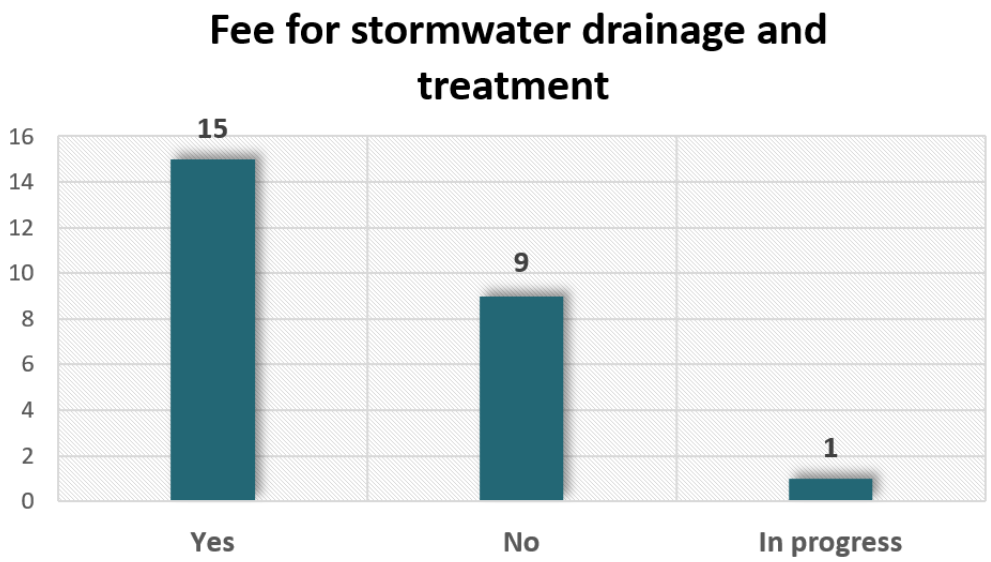


Figure 7. Application of stormwater fee in the municipalities.

Stormwater drainage basin management plans

Drainage basin approach is one of the principles of good stormwater management practice. Most (54%) cities have indicated having developed stormwater drainage basin management. However, of these only three cities (23%) have management plans for all basins, 23% have plans for at least one drainage basin, but 62% have a plan for general drainage basin.

Assessment of the existing stormwater management system

Half of the cities have done assessments of their existing stormwater management system (baseline analysis, collection of data, etc.). Only half of these cities have used hydrologic and hydraulic modelling to determine capacity of the system and flooding risks. Others have only assessed treatment quality / performed technical inspection and inventory / assessed institutional structures.

Main challenges with the stormwater management system and barriers for improving the system

Municipalities have indicated the following main problems with the existing system and barriers concerning improving the system:

- Lack of capacity in existing systems resulting in flooding risks (especially in extreme events), poor technical condition, especially where stormwater fee is not charged;
- Lack of finance (even in well-situated cities);
- Retrofitting is challenging in densely built areas (space, access);
- Stormwater treatment is insufficient, presence of foul connections, absence of regular water quality monitoring;
- Lack of quality control systems for dense urban areas;
- Low priority of the stormwater management on political agenda;
- Lack of a good collaboration and communication among different city departments and with other stakeholders;
- Lack of knowledge, especially concerning SUDS.

2.3. Organisation of the stormwater management and the integrated stormwater management

Ownership and management

Concerning ownership and management (governance) of the stormwater management system, in all of the cities, water utility participates in stormwater management and in the great majority of the cities (89%) also municipality participates in stormwater management. As a rule, water utility owns and manages combined sewers and, in some cities, – also stormwater sewers and in other cases – open systems (e.g., SUDS). Municipalities normally own and manage either separate stormwater systems or open systems.

Integrated stormwater management approach

The integrated approach to stormwater management (or ISWM) is becoming a prevailing paradigm in a holistic, sustainable urban stormwater management and nearly half (48%) of the municipalities reported having developed a plan or strategy for ISWM, and the same number have made a political decision to develop the ISWM, 45% have already established cross-departmental teams. Half (52%) of the municipalities have defined the vision, objectives, and expectations for the ISWM.

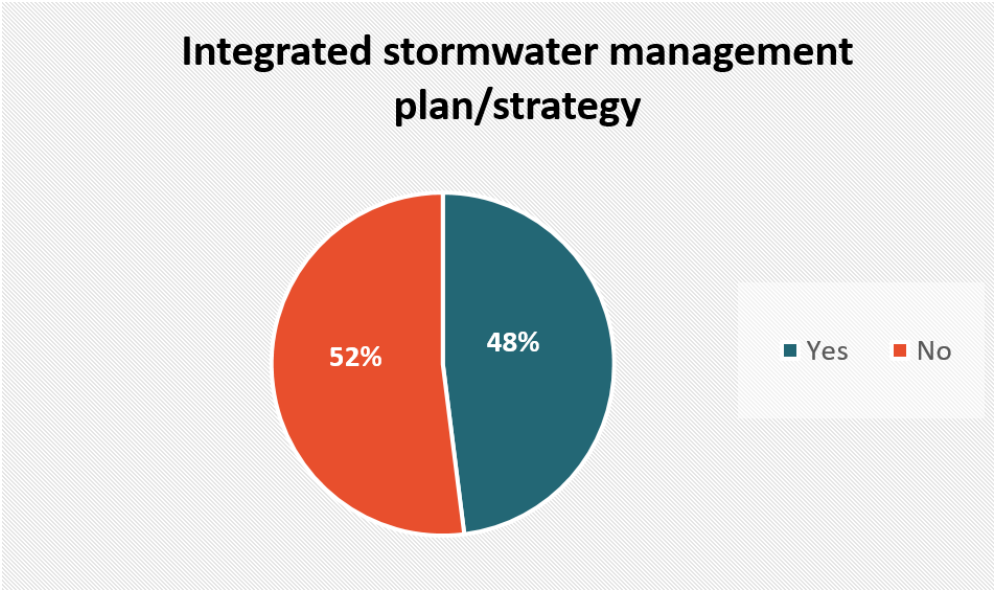


Figure 8. Presence of ISWM plans/strategies in the municipalities.

The need for the ISWM stems from the need to integrate different technical systems owned and managed by different bodies (combined/separate sewer system/drainage ditches/SUDS) and normally starts with the water utility and engineering/environmental department managing the sewers and later expands to urban planning and other departments.

Municipality institutions/departments involved in the ISWM in the respondent municipalities is summarised in the figure below:

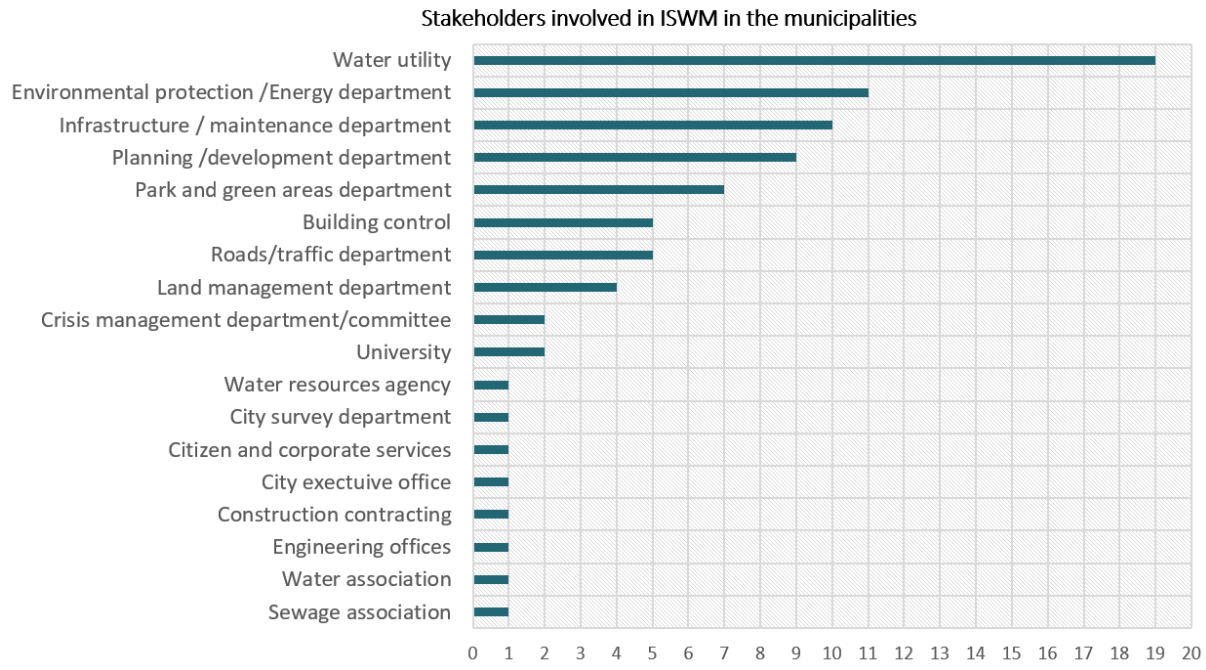


Figure 9. Number of municipalities where a specific stakeholder is involved in the ISWM.

There are numerous challenges concerning implementation of the ISWM. Only several municipalities indicated having adequate financial resources for setting up the ISWM system. Most municipalities have indicated that more knowledge and capacity building is needed to develop the ISWM system (mostly on design, construction, maintenance and impact of SUDS or NWRM, as well as integration of

pipe systems with open systems and spaces, e.g., modelling). Other mentioned problems mirror general challenges with the stormwater management systems, listed in section 3.2.

The need for cooperation with the state level authorities responsible for implementing the WFD and FD has been suggested, as well as the EU level legislation mandating or rewarding the integrated approach to stormwater management.

Stormwater planning tools

Ten municipalities employ stormwater planning tools, which are mostly recommended rather than binding. The tools include:

- Minimum elevation requirement;
- Requirement to place SUDS whenever possible;
- Green Area Factor (GAF) tool;
- Design specification taking into account discharge limitations;
- Flood risk assessment/stormwater plan by the developer;
- Stormwater fee.

Other municipalities plan to implement some planning tools, however the lack of knowledge and similar barriers to those relating to stormwater management in general have been mentioned, including conflict with landowners about placement of the integrated solutions.

2.4. Stormwater quality

More than half of the cities (54%) take stormwater quality into consideration when planning stormwater management in general. Some aspects of the stormwater quality management are described below.

National and local regulations

48% of the municipalities indicated only national law regulating stormwater quality, 16% have indicated only local regulations, in 23% both national law and local regulations and in once case – regional regulations have been mentioned. Three respondents (12%) answered with “no data”. Local regulations mainly concern industrial and traffic areas and constructions sites, no infiltration in high-risk areas as well as limit values in some cities.

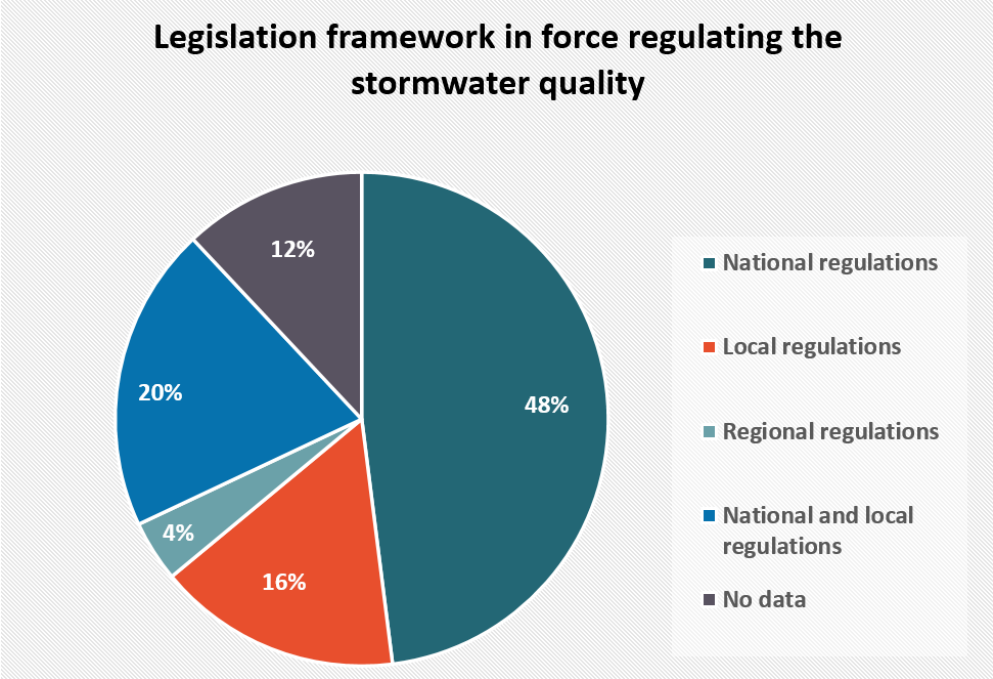


Figure 10. Legislation framework in force concerning stormwater quality requirements.

Measures for stormwater quality management

The measures for stormwater quality management that have been mentioned include SUDS/NWRM, grey treatment techniques (sedimentation/oil separators), pollution permits with allowed concentrations, stormwater quality monitoring, modelling, and risk assessment.

Stormwater quality monitoring

The stormwater quality is monitored in 52% of the municipalities. Monitoring mostly is done at the discharge points, as well as often in industrial sites/parking lots and other areas of potential risk. Most popular frequency of monitoring is once a month or after each major storm. More frequent monitoring in the framework of the project was reported by one municipality.

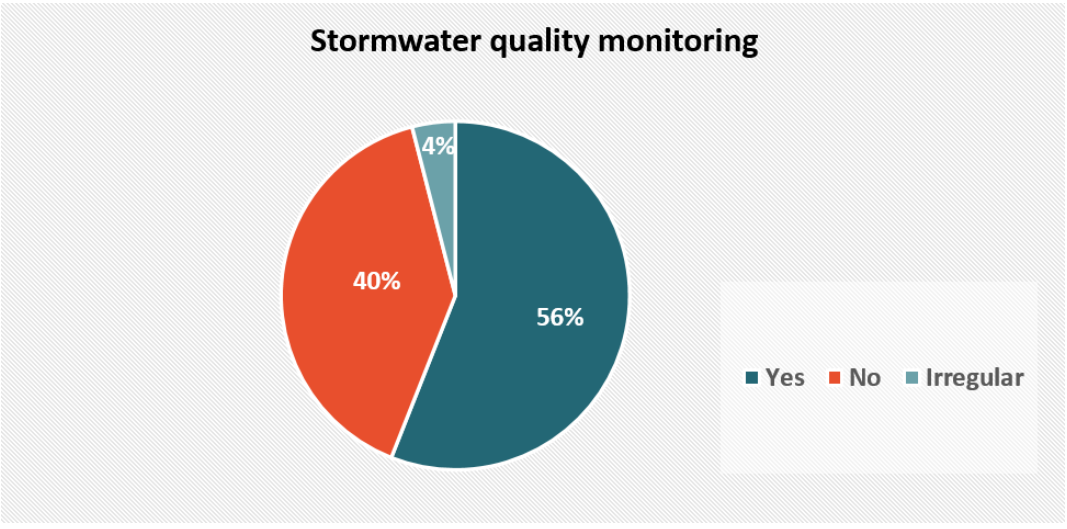


Figure 11. Stormwater quality monitoring in municipalities.

Nearly half of the municipalities monitor water quality based on land use (most often uniform quality requirements). Similar number of municipalities have identified high risk areas, which are high traffic

and industrial areas, construction sites, zinc/copper roofs. Half of the municipalities have regulations/instructions for stormwater from specific land uses. Limit values are set in 52% of the municipalities. SUDS/NWRMs are mostly not monitored.

The following substances are being monitored (N=18):

Substance monitored	Share of all municipalities performing monitoring
Suspended solids	78%
Nutrients (phosphorus, etc.)	61%
Organic substances (oil, fats, PAH etc.)	61%
Heavy metals	50%
Turbidity	39%
Other physiochemical parameters (colour, odours etc.)	39%
Conductivity	33%
Other emerging or priority substances	33%
Pathogens (e-coli, etc.)	28%
Chloride	22%
Microplastics	17%
Pesticides	11%
Macro plastics	6%
De-icing chemicals	0%

Table 1. Substances monitored in stormwater.

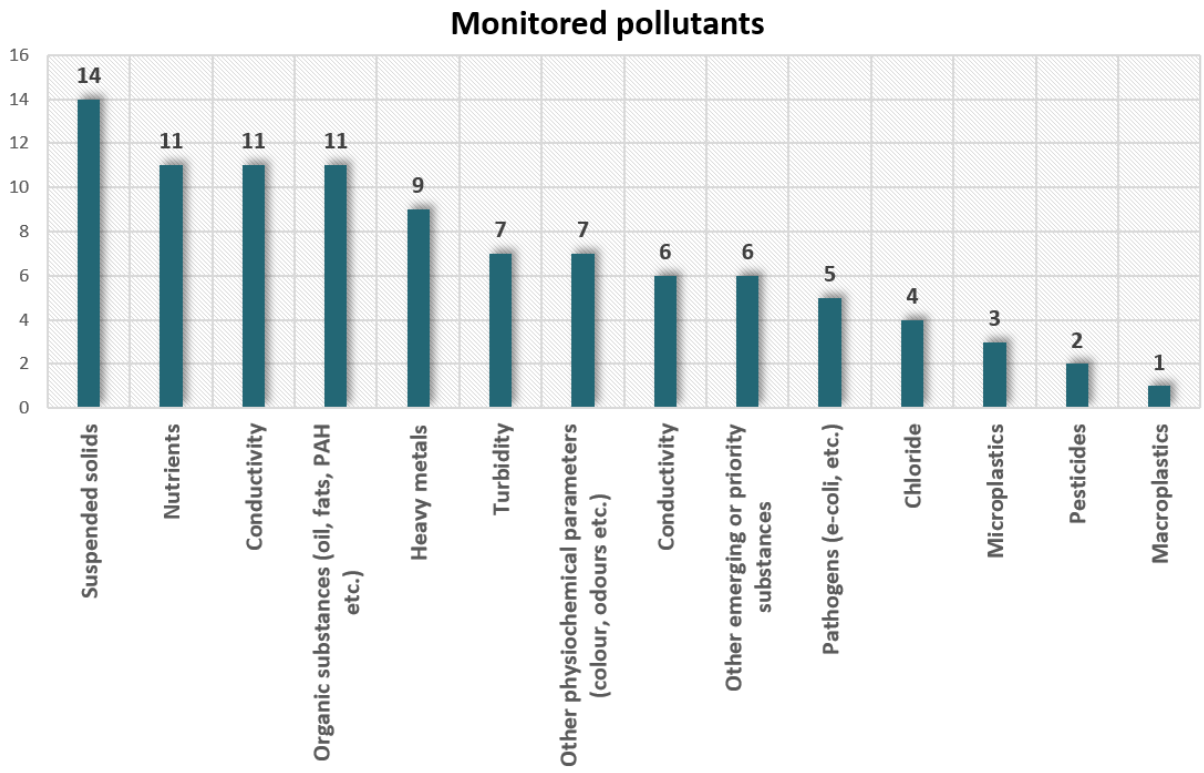


Figure 12. Number of municipalities where specific stormwater pollutant is monitored.

Main challenges for stormwater monitoring include high variability of both concentrations and flow and high associated cost of continuous sampling, as well as the lack of money, lack of information (risk areas, land use impact), lack of capacity, division of responsibilities between the local and national level.

Stormwater quality: future

Nearly all municipalities indicated the need to work more with monitoring per se, high risk area definition/cost efficiency, as well as to ensure continuous and long-term monitoring.

2.5. Survey results summary

One of the main conclusions of the survey on local specifics of stormwater management is that in most cities, there is awareness of and work on the ISWM concepts:

- Half of the surveyed cities have some kind of climate adaptation plans and some others are working on them;
- Most cities are applying catchment basin planning principles concerning stormwater and have developed catchment plans for at least some of the catchment basins in their territory;
- Many cities have stormwater management programmes/plans and guidelines for sustainable stormwater management;
- In most cities there is a fee for stormwater management;
- In most cities, stormwater quality is monitored, however, frequency varies.

Despite the fact that most cities work towards sustainable stormwater management, only in several cities (most notably Copenhagen and Helsinki) this is an overarching strategic approach, while in the majority of cities the adoption of approaches, tools or solutions is rather slow. The reasons for that include difficulty to find space for sustainable stormwater solutions, however very often there is a lack of common understanding and mutual collaboration among different municipal structures responsible for stormwater issues. Other obstacles include non-existence of mutually agreed goals, insufficient or inappropriate financing schemes for stormwater management, insufficient knowledge and data on stormwater quality, lack of local stormwater experts. Majority of cities recognized the need to inform and educate politicians and other decision makers on wide benefits of sustainable stormwater management.

Cities admitted that new policies, binding targets, and generous incentives are needed for transition to sustainable stormwater management.

The key findings of the survey suggest that existing stormwater management policies in the region to great extent are recommendatory, and thus can be considered as sufficient enough to justify the will of forerunner cities to improve their existing stormwater planning and management practices. However, for the majority of the BSR cities, as the prerequisite for transition to sustainable stormwater planning and management, new policies, binding targets and generous incentives must be in place, supporting the implementation of innovations in stormwater management and, among other, promoting and prioritizing on-site stormwater treatment approaches that improve urban environment, contribute to urban ecosystem services, and thus, have crucial role in increasing cities' resilience in the context of the climate change.

3. Recommendations for implementing ISWM at the EU, BSR, national and local level

Present policy recommendations for implementing integrated and sustainable urban stormwater management are based on accumulated knowledge and practices of those forerunner BSR cities that have already obtained experience, understanding and practical skills within the field of natural, holistic, and integrated stormwater management.

The underlying objectives of these recommendations are the following:

- Decreasing damages from urban floods associated with extreme precipitation events;
- Decreasing water pollution and ensuring good ecological status of urban streams, rivers, and other recipient water bodies;
- Enhancing urban biodiversity and value of ecosystem services;
- Achieving, where practical, natural water balance3;
- Ensuring combination of grey and green infrastructure that is most cost-effective and brings greatest mix of benefits;
- Creating multi-functional, socially inclusive, and integrated urban spaces.

3.1. Drivers for sustainable urban stormwater management

To understand what measures and policy instruments may facilitate the transition to a more sustainable urban stormwater management, including the introduction of the ISWM approach, broader trends, developments and drivers have been identified in the study, including:

- Development pressure in the urban areas and increasing intensity of the extreme storm events, and more prevalent flooding as a result, raising the political profile of the stormwater management;
- More stringent legislation at the EU and national level;
- Competition for public space from housing, commercial, transport, recreation, nature protection and other perspectives and the resulting drive to find quality and multi-functional solutions for the public space;
- Overall sustainability agenda, including European Green Deal;
- Worldwide recognition of stormwater as a resource rather than a problem and the shift from cost effectiveness paradigm (the need to find least costly solution to a problem) to cost-benefit paradigm (the need to maximise benefit to cost ratio through multiple functions);
- Increasing prevalence of polluter-pays and cost recovery principle, influencing introduction of a stormwater fee;
- Water utilities competence and their increasing role in stormwater management processes;

[3] For example, achieving complete natural water balance in an urban area that has been converted from a wetland, may not be practical, as it may threaten built environment through higher ground water levels etc.

- "Science-practice collaboration" – collaboration between the public sector (e.g., municipalities) and the research/academia institutions:
    - to support the public sector in the uptake of good stormwater management practices and tools,
    - to provide advice in the selection process of specific stormwater management solutions, etc.,
    - to ensure the knowledge-based decision making.

It is thus important to recognise these developments and reflect them in the smart choice of policy measures.

3.2. Recommended measures and policy instruments to facilitate integrated stormwater management

The table below summarises possible measures and policy instruments to tackle the most common problems in transition to integrated stormwater management approach, as identified by the municipalities, respecting the drivers described above.

Problem/barrier	Measures and policy instruments to tackle the problem/barrier
Limited space and capacity in dense historical parts	Planning, promotion, and financing for integrated public space reorganisation projects, combining with sustainable mobility initiatives
Lack of finance	Promoting solutions with multiple benefits, shift from cost effectiveness to cost-benefit approach. Valuing ecosystems services benefits. Stormwater fee to finance solutions (both connection and running fee). Property tax incentives if property switches to the decentralised solutions. Disconnection subsidy. Runoff restrictions/requirements for decentralized management in new developments to decrease pressure on the system. Including stormwater features into planning permits via GAF or similar tools.
Low priority of the stormwater management political agenda	Building solutions with multiple benefits emphasis on integrated management and integrated projects with the aim to create high-value multi-functional urban space. More data on water quality and damage caused by stormwater
Lack of a good collaboration model among different city departments and with other stakeholders	Promotion of integrated management and cross-sectoral work groups [4]; Agile/SCRAM approach in policy development

[4] ISWM System guidelines, http://www.integratedstormwater.eu/sites/www.integratedstormwater.eu/files/iswm_guidelines_2.pdf

Lack of knowledge	Strategic HR development Effective collaboration between knowledge holders, local competence development

Table 2. Typical problems with stormwater management systems and measures to tackle these.

3.3. Implementation of different aspects of ISWM

3.3.1. European Union level

As it has been discussed previously, EU level legislation regarding various topics of the ISWM is mostly sectoral:

- Water Framework Directive: focuses on water quality and water use aspects;
- EU Floods Directive: focuses on climate resilience and flooding protection;
- Nature Directive and Biodiversity Strategy: focuses on biodiversity protection, mainly in non-urban areas.

At the same time, several cross-cutting initiatives relevant to ISWM are ongoing, like Nature-Based solutions, Ecosystems services, European Green Deal, however they are so far connected more with research and application of best practices.

To speed up the introduction of ISWM at the EU level, and to facilitate not just solutions that focus on some aspects of ISWM (e.g., water quality, flooding protection, economic efficiency), as well as to address other urban challenges, more targeted EU level regulations and EU level guidance and incentives are needed for the implementation of liveable urban areas, combined with spatial planning, sustainable mobility (green street design), sustainable energy (passive cooling) and other aspects. These measures may include:

- Creating guidance documents on planning and creation of multi-functional and multi-benefit urban spaces, including cost-benefit analyses demonstrating higher benefit-to-cost ratio of green infrastructure projects compared with traditional projects;
- Specific requirements/criteria for transport and urban revitalisation projects under Cohesion Fund/European Regional Development Fund/Connecting Europe Facility and other EU funds to include multi-functional and integrated green infrastructure.

Pricing the stormwater runoff facilitates the use of rainwater as a resource as well as financial and economic sustainability of the stormwater management systems. As the EU leaves it to the Member States to decide on cost recovery of stormwater management, a guidance or recommendations for stormwater tariff might be helpful.

However, given that some Member States consider it a large burden to implement existing legislation, a balance should be struck between regulatory and recommending, incentives approach, which emphasises the benefits of the ISWM.

3.3.2. Baltic Sea Region level

3.3.2.1. Baltic Marine Environment Protection Commission (HELCOM)

HELCOM Recommendations 23/5 “Reduction of Discharges from Urban Areas by the Proper Management of Stormwater Systems” are currently being revised with the aim to integrate the current knowledge of the climate change impact on stormwater management, as well as to prioritise applications of new and emerging nature-based solutions and technologies. Besides reduction of discharges by proper stormwater management, several new aspects are added. Among them, more focus should be placed on preventive actions in planning phase and high-risk. In order to improve the quality of urban environment, the ecosystem services approach should be applied in stormwater planning. Stormwater should be seen as the resource for increasing wellbeing of the environment and citizens, maintaining biodiversity and promoting a good condition of surface and groundwater. Recommendations should have more focus to different type of pollution e.g., pharmaceuticals, microplastics etc.

3.3.2.2. EU Strategy for the Baltic Sea Region

Similar to the EU level, the EU Strategy for the Baltic Sea Region (EUSBSR) and the EUSBSR Action plan is rather sectoral than integrated, as evidenced below.

The following objectives and sub-objectives of the EUSBSR are relevant for the ISWM:

- Objective “Save the Sea” – sub-objective “Clear Water in the Sea”;
- Objective “Save the Sea” – sub-objective “Rich and Healthy Wildlife”;
- Objective “Increase Prosperity” – Sub-objective “Climate Change Adaptation, Risk Prevention and Management”.

Below the policy areas (PA), the actions relevant for the ISWM are listed:

PA Nutri – actions:

2. Reduce nutrient emissions from urban areas and other point sources.

PA Hazards – actions:

1. Prevent pollution and reduce the use of hazardous substances.

2. Mitigate and remediate historic contamination.

The mentioned policy areas are rather sectoral, and as such, sustainable stormwater management-related measures, supported under this framework, may have lower benefit-to-cost ratio compared to integrated project due to this narrow focus.

To bring more political motivation for a holistic, sustainable urban stormwater management and more liveable, climate-friendly, and climate-adapted cities in general, the integrated multi-functional solutions and the ISWM approach should be promoted specifically, by having a dedicated policy area for integrated solutions. For example, action “Liveable Cities” is suggested, which would raise the ISWM profile by combining it with other areas like housing and sustainable mobility.

3.3.3. National level

In order to promote faster implementation of the ISWM, a combination of regulatory requirements and guiding documents is suggested at the national and local (municipality level).

The state of play summary and recommendations for implementation of the various aspects of ISWM at national, regional and local level are included in the Annex 2. Main recommendations for the national level include:

- General principles and priorities of sustainable stormwater management defined in spatial planning and water management regulation, e.g., planning acts and acts regulating planning and design of stormwater system;
- Principles of ISWM included in the acts and other relevant regulations on spatial planning, depending on each country's regulations hierarchy;
- Drainage basin planning principle explicitly included in the spatial planning and water management regulation, e.g., planning acts and acts regulating planning and design of stormwater systems;
- Cost recovery principle for stormwater management infrastructure and multi-functional solutions defined in national law, at least allowing, and preferably requiring payment for stormwater runoff conveyance and treatment;
- Specify integrated approach to stormwater management, including the mechanism how an entity involved in stormwater management may invest and include in stormwater fee the cost of investing into other entity's property (e.g., water utility investment into city's parks or street infrastructure);
- Stormwater treatment mandated in legislation related to environmental permitting, spatial planning and planning and design of stormwater systems;
- Specify treatment and water quality requirements based on local specifics of stormwater drainage basins.

To allow for flexibility in local (municipality) application, rather than detailing procedures for the aspects described above in the national level regulation, national level guidance documents should be developed for the local implementation of the following aspects[5]:

- Guidelines on natural, holistic, sustainable urban stormwater management approaches and techniques and stormwater treatment;
- Guidelines on the elaboration of stormwater drainage basin plans;
- Guidelines on the establishment of the ISWM system in the local municipalities.

[5] Good example is Stormwater Guide (Hulevesiopas), 2012, by the Association of Finnish local and regional Authorities, **https://www.kuntaliitto.fi/julkaisut/2012/1481-hulevesiopas**

3.3.4. Local level

To promote the introduction of the ISWM approach, the following main recommendations are formulated for the local level:

- Local stormwater management programme and plan (as a part of climate adaptation plan or self-standing), containing priorities for sustainable and integrated stormwater management in the municipality, with time schedule and funding allocated for specific projects;
- Stormwater drainage basin management plans, including neighbouring municipalities for cross-border drainage basins, developed by inter-departmental teams within a municipality;
- Stormwater management guidance for developers and landowners (types of surfaces, typical treatment techniques, multi-functional solutions) – examples in the Annex 3;
- Regulations (roles, responsibilities, decision making procedure etc.) for the ISWM and the local task force present;
- Local requirements for emission limit values and monitoring of stormwater quality, based on the water status of the receiving water, as per custom water drainage basin management plans or, where limit values are not practical, treatment guidelines for specific land uses (e.g., residential/commercial/ industrial areas);
- Local financial incentives and building control tools (e.g., GAF tool).

The state of play summary and more detailed recommendations for implementation of the various aspects of ISWM at national, regional and local level are included in the Annex 2.

Annex 1 Stormwater management legislation

EU level legislation

EU Water Framework Directive 2000/60/EC (WFD) provides that good ecological status must be achieved in all water bodies. According to the WFD, river basin management plans are to be developed for river basin districts, assessing the ecological condition of the water bodies located in the river basin district, identifying the bodies at risk and measures for achieving good ecological condition. Good ecological quality is mostly related to reducing pollution and for that reason, in this context, it is important to identify the water bodies and the specific locations where pollution from rainwater can lead to a risk of not reaching good ecological condition and where special rainwater purification measures shall be implemented accordingly. Article 9 of the Directive provides for principles of recovery of costs for water services, which (in context of cities/towns) mean water supply and household sewage (incl. rainwater drainage into the common system). This principle does not directly apply to rainwater to be drained into separate system because for the purpose of the Directive water services do not include drainage of rainwater into separate system. That means that payment shall be applied on EU level for drainage of rainwater into the common system, yet application of payment for drainage of rainwater into separate system is not regulated, leaving it up to the Member States.

EU Floods Directive 2007/60/EC (FD) provides that river basin management measures are integrated in development of the river basin management plans prescribed by the WFD and the flood risk management plans prescribed by the Directive 2007/60/EC. Directive 2007/60/EC instructs to take a preliminary flood risk assessment in the entire territory of the country as groundwork to determine the flood hazard territories and prepare flood risk management plans for each river basin district.

EU Urban Wastewater Directive 91/271/EEC (UWD) has been ratified with a view to protect the environment from the adverse effects of discharging non-purified urban wastewater and wastewater from certain industrial sectors. The Directive is applicable to collection, purification and discharge of domestic wastewater, mixture of wastewater and wastewater from certain industrial sectors. Urban wastewater means domestic wastewater or mixture of domestic and industrial and/or run-off rainwater, in turn the Directive does not address rainwater that does not get mixed with domestic wastewater.

Directive 2008/105/EC on environmental quality standards in the field of water policy lays down environment quality standards (EQS) for priority substances and other pollutants as provided for in Article 16 of the WFD, with the aim of achieving good surface water chemical status.

Bathing Water Quality Management Directive 2006/7/EC was ratified on 24 March 2006 with the purpose to preserve, protect and improve environment quality and to protect human health by complementing Directive 2000/60/EC. The requirements of Directive 2006/7/EC were implemented in the Latvian national legislation with the Cabinet of Ministers Regulations No.608 adopted on 6 July 2010 “Regulations Regarding Monitoring of Bathing Water, Quality Assurance and Requirements for Informing the Public”.

Directive 2006/118/EC on the protection of groundwater against pollution and deterioration was ratified on 24 March 2006 and establishes specific measures as provided for in Article 17(1) and (2) of Directive 2000/60/EC in order to prevent and control groundwater pollution.

National, regional and local level legislation and guidance documents

Below, regulations and guidance documents are described on a national, regional (where applicable) and local level, to illustrate what maters get regulated on different levels in different Baltic Sea Region countries. The list of the legislative acts is not full; however, it provides some overview.

Denmark

National level

Environment Protection Law provides for protection of waters from pollution and competence of the Ministry of Environment and Food of Denmark to lay down more detailed requirements in relation to protection of waters.

Regulations on Permissions for Wastewater Drainage defines *rainwater as wastewater*, separating runoff from roofs and hard surfaces and providing that these must be clean of pollution (Part 2). In addition, the Regulations (Part 3, § 5) that local governments shall develop *wastewater management plans* (Spildevandsplanen), which, among other things, shall include connection with territorial planning, the existing and planned surface water drainage projects in connection with financing thereof. Part 6 of the Regulations "Adaptation to Climate" grants local governments rights to require provider of water services to develop *maps of flooded territories* due to rainstorms with the probability of once per 5, 10, 20, 50 and 100 years, considering the effects from climate change as at year 2050). The Regulations provide for methodology for developing maps of flooding territories (one-dimension and two-dimension hydrodynamic models). Part 5 of the Regulations provide for requirements regarding infiltration of wastewater, including rainwater, into soil.

Water Management Law provides that water management companies are directly or indirectly controlled by local governments and divides water management companies into water supply companies and wastewater drainage companies. It provides for obligatory benchmarking of performance results of water management companies and setting tariff limits for water supply and wastewater drainage. The Law provides for the Water Management Secretariat, which supervises the activity of water management companies, carries out benchmarking of their performance and efficiency evaluation, and sets tariff ceiling.

Law "On Procedure of Payment for Wastewater Drainage Services" provides for payment procedure of the connection and rainwater drainage tariff, prescribing options of compensating connection fee to service users, if they disconnect their property from the rainwater drainage system.

Guideline No. 27 "Functional Practice of Rainwater Drainage Systems" issued by the Rainwater Committee of the Danish Society of Engineers (IDA), which gives recommendations for designing rainwater sewerage. IDA has developed several other guidelines for rainwater management in relation to precipitation data, sustainable solutions, etc.

Planning Law provides for a planning system and competence of local governments. The Law provides for options of local governments to govern rainwater management in the territorial planning (kommuneplan) by setting certain territory usage, prescribing infrastructure territories, and setting territories where rainwater infiltration is allowed. Local plans may have a requirement to apply sustainable rainwater management solutions.

Local level – Copenhagen

Climate Change Adaptation Plan (2011), which assesses the predictable impact of climate change (higher sea level, increase in precipitation intensity, temperature increase and urban heat island effect, rising groundwater level) and provides for measures reducing the impact, largely emphasizing green infrastructure.

Cloudburst Management Plan, which provides for preparation measures for extreme cloudburst (probability of once per 100 years), as well as provides for the necessary changes in legislation to be able to implement the proposed financing models for the measures.

Wastewater Management Plan 2008 (with amendments made in 2016) provides for preparation measures for extreme cloudburst.

Estonia

National regulation

The Water Act has a task to ensure the purity and ecological balance of surface water bodies and groundwater. The Water Act regulates the use and protection of water, the relationship between landowners and water users, and the use of public water bodies.

Public Water Supply and Sewerage Act regulates the organization of the supply of registered properties with water and the discharge and treatment of sewage, stormwater, drainage water and other soil and surface water through public water supply and sewerage and establishes the rights and obligations of the state, local governments, water undertakings and customers.

Regulations of the Government of the Republic **"Requirements for Wastewater Treatment and Discharges of Wastewater and Stormwater, Limit Values for Wastewater and Stormwater Pollution Indicators and Measures to Control Compliance"** lays down requirements for the treatment of wastewater and for discharges of wastewater and stormwater, measures for monitoring compliance with those requirements and limit values for pollution indicators.

Regulations of the Minister for the Environment **"List of priority substances and priority hazardous substances, environmental quality limit values for priority substances, priority hazardous substances and certain other pollutants and methods for their application, environmental quality limit values for river basin specific pollutants, monitoring list of substances"** establishes environmental quality limit values for the list of priority substances and priority hazardous substances and certain other pollutants and the methods for their application for the assessment of the chemical status of bodies of surface water.

Regulations of the Minister for the Environment **"Requirements for hazardous substances discharged into public sewerage systems"** sets limit values for hazardous substances in wastewater discharged into public sewerage systems.

Regulations of the Minister for the Environment **"Procedure for the establishment of bodies of surface water and the list of bodies of surface water to be determined, the status classes of surface water bodies and values for quality parameters corresponding to the status classes and the procedure for determining the status classes"** establishes procedures for the establishment of watercourses, inland surface water bodies, lists of bodies of surface water to be identified, status classes for surface water bodies, including ecological and chemical status, values for quality indicators corresponding to status classes, and procedures for determining these status classes. The purpose of the Regulations is to ensure the protection of water bodies by assessing the status of bodies of water and to determine the status classes of bodies of surface water in such a way as to permit effective planning and implementation of water protection measures.

Regional regulation

West-Estonian River Basin Management Plan 2015-2021 has been prepared for planning the protection and use of water in the West Estonian river basin. The river basin management plans were based on the objectives and requirements of the WFD and the Water Act. A program of measures and a flood risk management plan accompanies the RBMP. The program of measures is an integral part of a water management plan, which sets out measures for the use, and protection of water.

Local level regulations – Tallinn

Tallinn Environmental Strategy 2030 is a conceptual basis documenting the long-term future of the city's environment, defining its vision of sustainable development, priority strategic goals and necessary action lines to ensure a decent living environment and resources for economic development without significantly damaging the natural environment and preserving biodiversity.

Tallinn Stormwater Strategy until 2030 is a reference document for the development of the sector, which provides general lines of action for urban development, taking into account the following aspects:

- flood elimination and prevention;
- drainage needs, solutions, operating principles, pre-flows, excessive drainage;
- minimization of harmful substances in stormwater, maintenance and improvement of catchments, water courses and standing water bodies;
- stormwater as a resource;
- sustainability, taxation, and economics of rainwater systems;
- maintaining the natural level of groundwater;
- minimizing the negative impacts of construction activities.

Tallinn Public Water Supply and Sewerage Development Plan 2009-2020 is the basis for the development of public water supply and sewerage up to 2020.

Other strategic documents such as city district master plans, detailed plans, environmental impact assessments, construction projects.

Tallinn Public Water Supply and Sewerage Rules regulate the relationship between water supply and sewerage, rainwater and drainage or other groundwater and surface water drainage company and users of water supply and sewage and rainwater drainage services connected to public water supply and sewerage in the territory of Tallinn. The Rules are mandatory for all legal and natural persons located in Tallinn.

Tallinn Maintenance Regulations together with the respective legislation of the state and Tallinn ensure the cleanliness and maintenance of the city.

Finland

National level

Land Use and Building Act, Chapter 13a sets out the objectives for the management of stormwater, responsibilities, monitoring, municipal wastewater system, authority tasks related to stormwater management, and planning. The overall objectives set out in the Act are:

1) Developing systematic stormwater management especially in areas where town plan is in force.
2) Infiltration and detention of stormwater at the source.
3) Preventing the impacts and damages to the environment and property caused by stormwater, while taking account of climate change.
4) Promote giving up the practice to convey stormwater into wastewater sewers.

According to the Act, the owner of the property is responsible for managing the stormwater created on the property. Municipality is responsible for arranging the necessary stormwater management services within the town plan.

Compliance with the provisions of Chapter 13a is monitored by a multi-member body appointed by the municipality. The multi-member body may issue general provisions on stormwater management. The provisions may apply to 1) quantity, quality, absorption, delay and monitoring of stormwater and the treatment of stormwater on the property; 2) connecting the property's stormwater system to the municipal stormwater drain; and 3) other issues related to stormwater management.

According to the Act, a municipality may collect a municipal stormwater fee for the properties belonging the area affected by the municipal stormwater drainage system.

The National Building Code contains regulations and instructions supplementing the Land Use and Building Act and the Land Use and Building Decree.

Act on Water Services ensures water services, which provide access to a sufficient amount of good-quality water for household use with respect to health at reasonable cost and appropriate sewerage in terms of the protection of health and the environment.

The Act applies to the sewerage for rainwater or meltwater (runoff water) accumulated on soil surface in built areas or the roof or other surface of a building as far as this is the task of the water utility. It provides for general development and organization of water supply, responsibilities and

rights of municipalities, water utilities and property owners, as well as fees and contracts for water supply and stormwater drainage.

According to the Act, a municipality may decide, after having negotiated with the water utility, that the water utility manages the sewerage for runoff water within an area to be specified in the decision in accordance with the needs relating to the development of a community.

According to the Act runoff water shall not be conducted from a property to the wastewater sewer of a water utility. If certain criteria are fulfilled, this can however be done.

Flood Risk Management Act lays down the provisions concerning the organisation of flood risk management. The purpose of the Act is to reduce flood risks, prevent and mitigate the adverse consequences caused by floods and promote the preparedness for floods. The purpose of the Act is also to coordinate flood risk management and other management of river basins, with due account for the needs relating to sustainable use and protection of water resources. According to the Act, the municipality is the main responsible body for planning the flood risk management.

Water Act. The purpose of the Act is to promote, organize and coordinate the use of water resources and the aquatic environment, so as to render it socially, economically and ecologically sustainable, prevent and reduce the adverse effects of water and the use of the aquatic environment and improve the state of water resources and the aquatic environment. The Act contains general provisions for all water management projects, as well as specific provisions for project types (e.g., drainage, watercourse regulation).

Environmental Protection Act. The stipulations on environmental protection are combined in the Environmental Protection Act. It is a general act on the prevention of pollution, which is applied to all activities that cause or may cause environmental damage. The Act requires that an environmental permit must be issued for any activity causing pollution. If stormwater may cause pollution of the watercourse, an environmental permit must be issued to manage it. The Environmental Protection Act provides for a groundwater pollution ban.

Government Decree on Substances Dangerous and Harmful to the Aquatic Environment defines substances which must not be discharged into the surface water or the sewerage system, the emission limit values and environmental quality standards for substances identified as hazardous or harmful. The aim of the Decree is to protect surface water, groundwater, and marine waters and to improve their quality by preventing and reducing the risk of hazardous substances.

Act on the Organization of River Basin Management and the Marine Strategy lays down provisions on the organization of river basin management and development and implementation of the marine strategy, the related analysis work, cooperation, and participation within the river basin districts and marine strategy implementation area, and international cooperation.

Government Decree on Water Resources Management lays down provisions on the accounts to be included in a water resources management plan, on the assessment and monitoring of the status of waters, and on the preparation of a water resources management plan.

Government Decree on Water Resources Management Regions defines water management areas and their functions. Finland is divided into eight water management areas, each of which has a water management plan.

Nature Conservation Law aims at maintaining biological diversity, conserve the beauty and scenic values of nature and promote the sustainable use of natural resources and the natural environment. The promotion of nature conservation also applies to the protection of water, such as streams, ponds and springs.

Act on the condition and maintenance of streets and certain public spaces. The Act defines the condition and sanitation obligations of streets, markets places, parks, and other similar public areas within the town plan. Obligations concern partly municipality, partly land or other area owner as provided by law. The maintenance of the street also includes measures that are necessary in winter conditions to keep the street in a satisfactory condition, including the removal of the rock used for anti-slip and maintaining of rainwater gutters and wells.

Regional level

Stormwater Guide, 2012, by the Association of Finnish local and regional Authorities provides a comprehensive and detailed guidance on the principles and specifics of urban stormwater management. It covers all main aspects of stormwater management including main principles, planning, organization and responsibilities for stormwater management, connection with land use planning, catchment basin planning, hydrology, hydrogeology, water quality, plants, and landscaping, as well as maintenance.

Baltic Sea Challenge, Joint Baltic Sea Action Plan for the Cities of Helsinki and Turku 2019-2023 lists voluntary actions to be taken and to be considered when managing diffuse loading and stormwaters in Helsinki.

Regional stormwater plan, 2014 is a stormwater plan based on catchment areas. Plan was done in cooperation with neighbouring municipalities. The plan concerns all the developing areas in the region. In the plan problem areas are recognized. Recommendations for stormwater management actions and plan regulations are also given.

Local level – Helsinki

The Municipal Building Order provides orders based on local conditions. The regulations may apply, inter alia, to construction site, management of the built environment and organization of water supply or stormwater, such as the management and treatment of stormwater on the site.

Municipal Building Order of the city of Helsinki sets orders to stormwaters from building sites and yards. According to the Order, stormwaters cannot flow to neighbour’s property area and stormwaters from construction sites containing solids, sludge or hazardous substances may not be discharged directly to watercourse.

The City of Helsinki's guidelines on stormwater management on plots provides the basis for planning stormwater management on plots. The guidelines, which are primarily intended for

designers, clarifies the relevant regulations and procedures, and provides guidance for the preparation of a stormwater plan.

Construction site water guidance, 2013 tells how to deal with different waters created on construction sites in a way that the waters and the harmful and hazardous substances the water might contain will not cause damage to waterways or other environment or structures.

City of Helsinki stormwater Management Program 2018 sets out the objectives, priorities, measures, and responsibilities for sustainable urban stormwater management in the city of Helsinki.

The City of Helsinki Instructions on Prevention and Control of Floods is a general guide, which gives advice of how to prepare for different floods.

City of Helsinki Climate Change Adaptation Guidelines 2017-2025 set out the vision, priorities, and measures for adaptation of climate change in the city of Helsinki.

Environment Protection Order of the City of Helsinki forbids leading contaminated waters from construction sites or car washing sites to water bodies or stormwater sewers without pre-treatment. Water can neither be filtered into the ground if it may cause contamination of groundwater or soil.

Local level – Turku

Municipal Building Order of the City of Turku, 2017 sets orders to stormwaters from building sites and yards. According to the Order, stormwater cannot flow to neighbour's property area or wastewater sewer. Order also encourages to detain and infiltrate stormwater on the properties.

Environmental protection order of the City of Turku, 2019 gives orders that concern stormwater quality. It is forbidden to cause pollution of environment via stormwater. Order also forbids leading stormwater from construction sites into water bodies without treatment.

Construction site water guidance, 2017 tells how to deal with different waters created on construction sites in a way that the waters and the harmful and hazardous substances the water might contain will not cause damage to waterways or other environment or structures.

City of Turku Stormwater Program, 2016 sets out the objectives, priorities, measures, and responsibilities for Integrated Stormwater Management (ISWM) in the City of Turku.

City of Turku Climate program, 2018 recognizes stormwater floods to be significant risk in the future. The program examines stormwater situation in connection to other issues like seawater floods and ecosystem services. The requires actions are linked with the measures in the stormwater program.

Preliminary stormwater flood risk assessment, 2018 gives information about potential stormwater flood areas. Risk assessment is based on surface modelling. Information is used in city planning to recognize current problem areas and areas that require special flood protection actions when they are developed.

Germany

National level

Federal Nature Conservation Act provides for preservation of natural balance, which can be achieved through environment protection and landscape management. The purpose of the Act is to decrease adverse effects on the environment.

Federal Water Act is the most important water management related federal act, which ensures incorporation of EU directives in the German national and regional legislation. The Act comprises general sustainable legal groundwork of water management, applies to all surface, coastal and ground waters and gives a layout as to organising management and the results to be achieved, for example, it prescribes limited usage of hazardous substances in management, construction and operation of a sewerage system, appoints a water protection commission, provides for development of water bodies and basins, water protection and flood zones.

Wastewater Ordinance lays down minimum requirements for receipt of wastewater discharge permission. The requirements include testing for pollution in the treated wastewater both in case of direct and indirect wastewater discharge. The Ordinance takes into account the UWD, which states the technical requirements for wastewater discharge. The Ordinance governs protection of groundwater against pollution caused by wastewater discharged by 57 divided industrial sectors[6]. The Ordinance is applicable to collection, purification and discharge of domestic wastewater, mixture of wastewater and wastewater from separate industrial sectors.

Ordinance for the Protection of Surface Waters ensures protection of surface water bodies and efficient use of their water resources. The Ordinance incorporates water body quality standards (in accordance with the WFD) into the national legislation. The Ordinance prescribes determination of location and boundaries of water bodies, classification of water bodies into categories within framework of river basin district and division of the categories into types, identification of artificial and highly modified water bodies, as well as characterisation of water body condition and assessment of adverse effects from human activity.

Wastewater Charges Act prescribes a fee for discharging wastewater, which depends on the wastewater's quantity and pollution level. The purpose of the Act is to create an economic incentive to reduce the pollution load from discharged wastewater. The charge is levied by the regional authority (Länder) and this income is to be used to ensure water quality. The regional authority (Länder) is entitled to lay down conditions, under which rainwater discharge can be entirely or partially separated (deducted) from the wastewater discharge fee. If rainwater enters the sewer and is treated, it is part of the calculation base for the fee.

[6] It sets the effluent limits for direct discharges (after treatment) for those industries that do not send their water to the municipal wastewater treatment.

Standards issued by the German Association for Water, Wastewater and Waste:

Standard DWA-A 138: Planning, Construction and Operation of Facilities for the Percolation of Precipitation Water is addressed to town planners, architects, landscaping planners and civil engineers and contains generally acknowledged rules of technology. It provides information and prescribes common practice as to dimensioning, design, construction, and functionality of rainwater management solutions. In particular, this standard sums-up the latest information about rainwater management solutions. The Standard applies to usage of rainwater filtration using permeable surfaces, as well as to collection of rainwater in residential areas from rooftops, terraces, parking lots and driveways.

Standard DWM 153: Recommended Actions for Dealing with Rainwater provides substantial considerations for the competent authorities – local governments and planners – in relation to town planning and sewerage system planning. The Standard comprises recommendations as to rainwater amount and management quality. It analyses and structures:

- pollution and amount of rainwater depending on usage and pavement of land surface;
- groundwater protection requirements;
- surface water protection requirements.

This is based on the way of determining rainwater management mechanisms which would be necessary to increase infiltration, or to discharge rainwater to surface water bodies.

Standard DW-M 119 (Nov 2016): Risk management in municipal flood prevention for drainage systems during heavy rain. It adds information how to determine risks of damage and hints on possible measures.

DW-A 102-1 (Dec 2020) Principles for the management and treatment of stormwater for discharge into surface waters. A new parameter is introduced: fine suspended solids (all particles between 0,45 – 0,63 µm). The parameter is introduced because it contains most of the transported heavy metals and organic pollutants. This guideline introduces the principle of local water balance as well, e.g., to minimize the changes to the natural water balance conditions if nothing was built in the area. Three more parts about emission-based evaluation, water balance and biological aspects in the emission-based approach are still to come.

Federal land / Local level – Berlin

Berlin Local Government Statute: Local governments have rights to implement binding regulations within boundaries of their territory, for example, to set the wastewater fee amount and provide for an obligation to connect to the municipal water supply and sewerage system.

Berlin Wastewater Drainage Plan is one of the planning instruments of water resources. Wastewater drainage plans are prepared by the regional authority (Länder) with consideration of the factors stated in the Federal Water Act, and their purpose is to ensure optimal wastewater management in the interests of water protection. The plan provides for actions to improve the current condition of river basins and to implement wastewater purification principles.

Berlin Rainwater Discharge Regulations provides for preconditions for safe discharge of collected rainwater into groundwater and for rainwater infiltration.

Latvia

National level

Water Management Law and the related Cabinet Regulations – provide for development of river basin management plans to ensure good ecological situation.

Daugava River Basin Management Plan (RBMP) and Flood Risk Management Plan (FRMP) for years 2016-2021 has been approved. RBMP does not provide for measures aimed at rainwater management in the territory of Riga (surface water object D413SP). The specific goal No. 5 of RBMP is "To prevent flooding of local territories caused by rain and spring high water, by arranging and developing surface runoffs and rainwater drainage systems", without stating specific territories.

The Cabinet of Ministers Regulations No. 34 **"On Discharge of Polluting Substances into Water"**, which classify run-off rainwater as wastewaters and provides for requirements in relation to polluting substances in wastewaters.

Law **"On Local Governments"** provides that collection, drainage, and purification of wastewaters irrespective of the ownership of the residential property, as well as flood control measures are the autonomous functions of local governments, which might be in conflict with the Land drainage Law, which provides that land drainage systems of local government significance for common use.

Spatial Development Planning Law entitles a local government to govern rainwater management in the spatial plans, local plans, detailed plans, and thematic plans.

Law on Water Management Services, which states that rainwater drainage into centralised collecting systems is a public water management service, in turn rainwater drainage into separate system is not public water management service; the Law also provides that local government shall issue binding regulations regarding operation and usage of centralised sewerage, as well as that local governments CAN issue binding regulations regarding rainwater management. When turning to the Ministry of Environmental Protection and Regional Development for advice it could not be clarified whether the mentioned binding regulations may include a tariff for rainwater management.

Cabinet of Ministers Regulations No. 174 of 22.03.2016 **Regarding the Provision and Use of Public Water Management Services**, which provide that the amount of rainwater drained into the common system shall be included in the total amount of wastewater, for which the service user shall pay to the service provider.

Cabinet of Ministers Regulations No. 327 of 30.06.2015 Regarding Latvian Construction Standard LBN 223-15 "Sewerage Constructions", which provides for the method of calculating the amount of rainwater to be drained into domestic sewerage, as well as technical requirements as to designing rain sewerage.

Land Drainage Law, which states that 1) the land owner or legal possessor shall perform the initial inventory of the land drainage system of a single property and of an land drainage system for

common use; 2) an land drainage system of a single property shall be operated and maintained by the owner or legal possessor of the relevant land; 3) an land drainage system for common use shall be operated and maintained by owners or legal possessors of the relevant land 4) the construction, operation, and maintenance of an land drainage system of local government significance for common use shall be ensured by the owners or legal possessors of the relevant land. The local government may participate in construction, operation, and maintenance of a land drainage system of local government significance for common use.

Cabinet of Ministers Regulations No. 714 of 3.08.2010 "On Operation and Maintenance of Land drainage System" provides for requirements to be met by owner or legal possessor of land in usage, care and preservation of land drainage system, imposing high liabilities on owners and legal possessors of lands.

Cabinet of Ministers Regulations No. 378 of 7.07.2015 "Regarding Procedure of Calculation, Distribution and Payment of Construction, Operation and Maintenance Costs and Procedure, under which a Local Government Participates in Construction, Operation and Maintenance of Land drainage System of Local Government Significance for Common Use, as well as in Covering the Mentioned Costs" provides that a local government CAN finance construction of an land drainage system of local government significance for common use, except cases when emergency situations resulting from violations of laws and regulations (failure to take care of or filling ditches) must be eliminated.

Cabinet of Ministers Regulations No. 623 of 13.07.2010 "Land Drainage Cadastre Regulations" state that landowners and local government shall submit information regarding land drainage system to the land drainage cadastre information system of VSIA "Zemkopības ministrijas nekustamie īpašumi".

Local level – Rīga

Binding Regulations of the Riga City Council No. 147 "Regulations for Usage and Maintenance of the Riga City Hydrographical System" provides for the following responsibility for stormwater management and land drainage system infrastructure maintenance:

Riga City Traffic Department:

- main collectors, culverts, wells within red lines
- pump stations

Riga City Council Housing and Environment Department:

- land drainage ditches, ponds

Executive boards:

- collectors in municipal properties beyond red lines
- water bodies: Lake Bābelītis, Lake Baltezers, Lake Gaiļezers, Lake Velnezers and Lake Dambjpurva

Owners, legal possessors, users:

- networks owned by them beyond main networks
- culverts crossing their land
- separately: the hydrographical system in their land

Binding Regulations of the Riga City Council No. 39 "Regulations for Operation, Usage and Protection of the Riga Water Main and Sewerage Systems and Constructions" state that service provider is the company rendering public water management services, its obligations include drainage of wastewater, in turn wastewater is defined as only the runoff rainwater which is drained into the city's sewerage system. The regulations also provide that rainwater drainage systems are not accepted in the balance sheet of the service provider.

Lithuania

National level

The Republic of Lithuania **Water Law** regulates the relations arising from the use, management, and protection of water in the natural environment. The law sets basic principles and norms regarding water management, water use, water use stakeholders' rights and obligations, as well as concerning as well as for river basin district management plans.

Order No 02.04.2007 of the Minister for Environment of Lithuania D1-193 **"Stormwater Management"** lays down environmental requirements for the collection, treatment, and discharge of surface water to protect the environment from pollution. The rules are in line with the UFD and the HELCOM Recommendation 23/5 on the reduction of emissions in urban areas and the correct management of stormwater. The order lays down basic principles for rainwater management, including the maximum possible reduction of runoff close to the source, infiltration, as well as water purification.

It specifies, among other things, that during planning and design, potential should be evaluated, and preference given to:

- reducing the formation and/or collection of surface wastewater (as few impermeable surfaces as possible must be installed (except for potentially contaminated areas), facilities for immersing clean surface water into the ground must be installed, as few potentially polluted areas as possible are planned, etc.);
- reducing the amount of surface wastewater discharged into the environment in a centralized manner (e.g., intended use of surface wastewater for production, irrigation of green areas, firefighting, installation of filter strips, absorption paths, containment and / or storage ponds, etc.);
- reducing the pollution of the generated surface wastewater (e.g., to provide for dry cleaning of potentially polluted areas, to install roofs in the most dangerous places in terms of pollution, etc.).

The order specifically states the treatment of stormwater, specifying need to treat the flow for certain areas, for example 24 l/s for area 2 ha. For areas more than 3 ha, at least 15% of the peak flow should be treated.

The order also determines maximum permittable concentrations (average annual and maximum instantaneous) for SS, BOD7, Oil products as well as detailed requirements for monitoring stormwater quality. The order specifies pollution permits for areas more than 10 ha and more than 1 ha of potentially polluted sites.

Order of the Minister for Environment 21.07.2003 of the Republic of Lithuania on the Construction Standard STR 2.07.01: 2003 **"Water and Sewers. Building internal networks. External networks"** determines the procedures and methodologies for the design and construction of stormwater sewer networks (Annex 9 of the construction standard). The standard does not include any information or guidance on designing sustainable drainage systems.

The Law of the Republic of Lithuania on **Drinking Water Supply and Wastewater Management**, inter alia, defines surface water drainage infrastructure as one of public water services and thus creates a solid legal base for stormwater infrastructure to be managed by the water companies. The Law determines that the surface water drainage is a paid service, with the tariff calculation methodology being determined by the State Price and Energy Control Commission.

State Energy Regulatory Council Ruling on the approval of the methodology for pricing drinking water supply and wastewater treatment and surface wastewater treatment services sets the detailed provisions for calculation and setting of surface water tariffs, on par with drinking water and wastewater.

Recommendations for the Design, Implementation and Maintenance of Environmental Measures. Protection of Water Bodies APR-VTA 10 by the Lithuanian Road Administration under the Ministry of Transport and Communications provide comprehensive guidance on the measures to protect water bodies from the pollution created by road construction, maintenance and accidents that concerns mostly with stormwater. It contains guidance on basic concepts, potential impacts, road design guidelines to minimise water pollution, as well as measures to limit exposure. the document contains design, construction, maintenance, and monitoring guidelines of specific stormwater runoff treatment features, including sustainable techniques like swales, infiltration tanks, artificial wetlands, stabilizing ponds, sedimentation ponds.

Local level

On local level, according to the national legislation, local municipalities determine **Rules for the Use of a Surface Wastewater Treatment System,** which dictate procedures for connection, installation, adoptions, and maintenance of stormwater management system, including division of responsibilities between users and a manager (water company or municipal department). The rules also regulate payments for stormwater discharge.

Poland

National level

Environmental Protection Law defines the principles of environmental protection and conditions for the use of resources, taking into account the requirements of sustainable development. It sets rules for determining conditions for the protection of environmental resources, conditions for introducing the substance or energy into the environment, costs of using the environment. It determines obligations of administrative bodies, as well as liability and sanctions.

The Water Law creates a framework for the sustainable development of water resources. The Law is composed of ten Chapters: General provisions (1); Use of water (2); Water protection (3); Water

building (4); Prevention from flood and drought (5); Management of water resources (6); Water companies (7); Liability for damages (8); Penal provisions (9); Final provisions (10). The aims of management of water resources are in particular: supply of appropriate quantity and quality of water for the population. It is a comprehensive instrument implementing both WFD and FD.

Pursuant to the Act as of 1 January 2018 Państwowe Gospodarstwo Wodne Wody Polskie was established as a central institution responsible for national water management. Prior to 1 January 2018 stormwater and snowmelt, discharged to open or closed drainage systems, coming from polluted areas with durable surface was considered sewage. At present stormwater and snowmelt discharged to open or closed drainage systems is not qualified as sewage. However, the stormwater discharged to the general sewage system is treated as municipal sewage.

The Water Law creates a foundation for a systemic solution to previously neglected urban flooding issues. The Act takes into account the problems of flood risk management and counteracting the effects of drought. Of particular importance is a change in the approach to stormwater, which is seen in the resource category.

The Water Law determines the principles and mechanism for fees for stormwater and snowmelt drainage to waters and for the reduction of natural area retention. The former fee, according to the law, consists of fixed and variable part.

Regulations of the Council of Ministers of 22 December 2017 on unit fee rates for water services further details application of stormwater tariff.

Regulations of the Minister of Marine Economy and Inland Navigation of 12 July 2019 on substances particularly harmful for water environment and conditions to be met upon introduction of sewage to waters or soil as well as upon introduction of stormwater or snowmelt to waters and water devices. According to Polish law, it is possible to transport sewered run-off (rainwater or snowmelt) without treatment directly to the receiver (such as water, water devices or – in some cases – ground), if it is discharged from unpolluted areas (i.e., residence areas, pavements etc.)

From heavily contaminated areas (i.e., industrial areas, roads, airports, fuel storage and distribution facilities) it is permitted, if following quality parameters are not exceeded: TSS concentration of 100 mg/L and concentration of petroleum substances of 15 mg/L.

In case of water reservoirs (including lakes) with constant inflow/outflow of surface waters, it is allowed to discharge stormwater from overflows, if the average annual number of discharges from individual overflows does not exceed 5.

Under no circumstances, rainwater/stormwater cannot be discharged to groundwater as well as to water devices – in case of rainwater that contains substances which are considered to be particularly harmful to aquatic environment.

In exceptional situations (with the permission of the competent authority):

- run-off (rainwater/snowmelt) or stormwater from overflows can be discharged into receiver (surface water or ground) less than 1 km from bathing areas,
- it is possible to discharge rainwater or snowmelt to lakes and their tributaries, if the time of inflow of these waters to the lake is shorter than 24 hours,

only if it does not interfere with water quality requirements.

Regulations of the Minister of Transport and Water Economy of 2 March 1999 on technical conditions that should be met by public roads and their location §106. The provision states that storm drain shall be completed when it is not possible to drain the water via devices for surface drainage or when it is required by separate provisions and it specifies technical conditions that should be met by storm drain along roads.

Act of 8 March 1990 on self-government. In cities the individual stormwater management systems usually create one shared storm drain. This way water management is shaped in the urban area which according to the act on communal self-government is one of the commune's own tasks.

Act on Collective Water Supply and Collective Sewage Disposal sets out the terms and conditions for collective water supply intended for human consumption and collective sewage disposal. It sets the rules for activities of water and sewage companies, conditions to ensure the continuity of supply and adequate water quality, reliable sewage disposal and treatment, for protecting the interests of service recipients, taking into account security requirements, the environment and cost optimization. It determines the requirements for the quality of water intended for human consumption as well as tariff approval procedure, including stormwater tariff, and regulatory body and its tasks.

Act on nature protection defines the objectives, principles, and forms of protection of living nature and habitats. Prohibits alterations in protected natural areas with exceptions made for storm protection, flood management.

Ordinance of the Minister of the Environment on substances that are particularly harmful to the aquatic environment and the conditions to be met when entering wastewater into the ground, as well as when discharging rainwater or meltwater to waters or water facilities. The ordinance specifies the substances which are particularly harmful to the aquatic environment causing water pollution, that should be eliminated or restricted. Among other things related to wastewater, it sets the conditions that must be met when discharging rainwater or meltwater into waters or water facilities, including the highest permissible values of contaminants, the manner, location and minimum frequency of sampling, as well as reference methodologies for analysis and assessment.

Ordinance of the Minister of Maritime Economy and Inland Navigation on determining tariffs, sample application for tariff approval and terms of settlements for collective water supply and collective sewage disposal. The ordinance specifies the detailed methods of determining tariffs, including criteria for determining the necessary revenues, allocation of costs to tariff groups of service recipients, criteria for differentiating prices and rates. It contains sample application for tariff approval as well as the conditions of settlements for collective water supply and collective sewage disposal. Water supply and sewage disposal company must determine the tariff in a way that ensures obtaining necessary revenues, protecting service recipients against unjustified increases in prices and rates of charges, as well eliminates cross-subsidization. The tariff must also motivate service recipients to use water rationally and reduce sewage pollution as well as ensure ease of calculation and checking of prices and rates of fees.

Local level – Elbląg

Protection strategy of the environment within the Elbląg region gives an assessment of the quality and protection status of surface waters in the Elbląg region; these include Bauda, Elbląg, Pasłęka, Wałsza, and Wąska rivers, Elbląg and Jagielloński channels, Drużno and Pierzchalskie lakes, and The Vistula Lagoon.

The strategy contains a compilation of data related to industrial and municipal wastewater and sewage treatment facilities in the region, such as maximum capacity and recorded sewage water inflow to treatment plants.

Environmental protection program for the Elbląg region for 2010-2013, with an outlook for 2014-2017 describes the Elbląg region – geographic location, demographics, climate, economy, as well as the relevant environmental hazards, management strategies and education. This includes an overview of wastewater management practices and an assessment of flood risk in Elbląg county, with the Marcus, Elbląg and Tolkmicko municipalities being identified as highest in risk of flooding. Measures to be taken for protection against floods and droughts are suggested.

Resolution No. III / 66/2019 of the Elbląg City Council on the regulations for water supply and sewage disposal sets out the rules for collective water supply and collective sewage disposal in the City of Elbląg by the water supply and sewage company, and the rules for the use of these services by the recipient.

Outlined are:

- The minimum level of services provided by the water and sewage company in the field of water supply and sewage disposal;
- Conditions and procedure for concluding contracts with service recipients;
- The method of settlement based on the prices and rates of fees set in the tariffs;
- Conditions for connecting to the network;
- Technical conditions determining access to water and sewage services;
- The method of water and sewage company collecting the completed connection;
- Procedure in the event of failure to comply with services and appropriate parameters of the water supplied and entering the sewage network;
- Standards of service for recipients of services. Ways to handle complaints and exchange information on disruptions in water supply and sewage disposal;
- Conditions for providing water for firefighting purposes.

Resolution No. VII / 186/2019 of the Elbląg City Council on determining the fee for the discharge of rainwater or meltwater into stormwater drainage systems from 1 January 2020, sets the annual fee to PLN 1.54 (net), i.e., PLN 1.66 (gross) for 1 m^2 of land with permanent sealed surface and roofs.

Sweden

National level

Environmental Code – combined normative acts governing 15 different environment areas. The Code defines rainwater as wastewater and provides for wastewater purification prior to its discharge into the environment.

Regulations on Polluting Activity and Public Health provides for purification of wastewater (incl. rainwater) unless it is proved that discharge of wastewater does not cause harm to the environment or the public health. The Regulations provide for rights of the Environment Protection Agency to develop additional conditions regarding wastewater purification.

Planning and Building Act enables local governments to lay down special requirements and guidelines as to rainwater management in certain territories (runoff, purification, height marks, etc.) Part 4, 12§.

Public Water Services Act defines public water services, which include water supply, domestic sewerage, rainwater management and land drainage (drainage). The Act provides that local government has a duty to provide public water services (directly or through one or several companies which are controlled by the local government and render water services or several other municipal services). The Act states that users of public water services pay a fee for water services to the provider of water services, covering the costs of the service provider (incl. system development and maintenance).

Regulations on Public Water Services states that local government may issue respective binding regulations governing water management infrastructure, providing for cooperation between various institutions accordingly.

P110 Recommendation of the Swedish Water Management Association "Drainage of Domestic Wastewater, Rainwater and Drain Water: Functional Requirements, Hydraulic Designing and Public Sewerage Construction Designing" – these Recommendations are not of binding nature, yet they are mostly applied in designing and building sewerage constructions. The 2016 wording of the Recommendations comprises guidelines for sustainable rainwater management solutions.

Local level – Malmo

Binding Regulations of the Water Management Company VA SYD Regarding Maintenance of the Public Water Management, which provide for rights and obligations of the water management and its users, including installation of connections and payment procedure, as well as provides guidelines regarding rainwater purification. The water management company has an obligation to provide a connection for rainwater drainage if there are no other options for rainwater management within the scope of a piece of land (the connection is not obligatory).

Malmo Local Government Guidelines for Rainwater Management / Malmo Rainwater Strategy – the Guidelines provide for cooperation between different municipal departments and water management companies and their role in rainwater management, classification of receiving waters, as well as classification of rainwater depending on land usage and the runoff surface.

Norway

National level

Regulations on Pollution Control defines the parameters, permissible values, and methods of analysis of pollutant density from wastewater and sewage treatment plants. The regulations states that no one may initiate new emissions or increase emissions significantly without permission granted by the municipality, and the procedure for obtaining such a permit is detailed. By defining geographical areas as sensitive, normal or less sensitive, the minimum required reductions of pollutant density are defined for sanitary wastewater discharge from residential houses, cabins, tourist companies, etc., municipal wastewater from urban settlements. The regulations lays out a framework for calculating municipal water and sewerage fees.

The Planning and Building Act defines the requirements that must be met prior to construction work, including the drainage of ground and runoff water. The same applies to the maintenance of drainage for existing buildings.

State planning guidelines for climate and energy planning and climate adaptation help municipalities and counties prioritize work on reducing greenhouse gas emissions, and contribute to ensuring that climate adaptation is taken into account in planning according to the Planning and Building Act, facilitate more efficient energy use and environmentally friendly energy conversion in the municipalities, provide that municipalities use a wide range of their roles and instruments in the work on reducing greenhouse gas emissions and climate adaptation, and contribute to balancing and coordination when emissions reduction and climate change affect or conflict with other considerations or interests. The guidelines advise on the preparation of energy and climate adaptation plans and their content as well as provide guidance on integrated climate adaptation, including stormwater management.

Local level – Oslo

Oslo Strategy for Runoff Water Management 2013–2030 briefly outlines some strategies for reducing the risk of flooding and the damaging effects of heavy rainfall, such as use of green roofs and green and permeable surfaces instead of dense asphalt. The strategy sets out some goals for future runoff water management systems: to meet climate challenges and minimize inconvenience to people and damage to buildings, real estate and infrastructure, to protect the environment and ensure good ecological and chemical status in water bodies and to use runoff water as a resource in the urban landscape.

Oslo Council Action Plan for Runoff Water Management expands on the previously outlined goals to develop an open flood and delay network that works in conjunction with the piping systems and contributes to a more robust city that copes with precipitation better. Oslo aims to treat as much as possible of the rainwater above ground, with open and local stormwater solutions, based on the three-step strategy. Agency for planning and building services coordinates the implementation of the action plan, because Oslo has decided to use this cross-sectorial approach, with open and local stormwater solutions, that includes several agencies and other actors. Oslo has a **strategy for stormwater quality** (page 4 of action plan), with open and local stormwater solutions, the city strives to ensure that the damage caused by stormwater and urban flooding is avoided, all stormwater that

is conveyed to a recipient is of a quality that can be handled by the recipient, so that targets specified in the water regulations are achieved (according to the WFD), and/or stormwater is infiltrated, retained and used locally where practicable, using open and multifunctional retention networks.

Oslo Council Water and Drainage Agency's Guide to Construction describes the application process, requirements and fees for building permits in the cases of construction or drilling near the municipality's wiring system, new or changed connection to water and wastewater systems (municipal and private), excavation or elevation (more than 50 cm) etc. near the municipal wiring system, discharge of contaminated wastewater from businesses or construction work.

Oslo Council Water and Drainage Agency's Stormwater Management Guide for Construction specifies the main rules for stormwater management in a development process and provides an overview of current legislation. The rules are specified based on which phase of the construction process the development is in. The main message is that runoff water management must be included in the land use plan and that it should always be handled openly and locally.

Urban Ecological Programme 2011-2026 is the municipality's adopted environmental policy and provides political guidelines for runoff water management in Oslo. The program emphasizes that the runoff water should be handled locally so that the natural water cycle is maintained, and nature's self-cleaning ability is utilized. It also stipulates that Oslo must have an environmentally efficient management of drinking water, waterways, groundwater, and the fjord, as well as emphasis should be placed on utilizing rainwater and meltwater as a natural resource and aesthetic element in the outdoor areas.

Russia

National level

There is no separate legislation on the stormwater management in Russia. Regulations of the stormwater is based on the common water legislation and mainly as a part of wastewater management.

The main document regulating the water management in Russia is **Water Code** of Russian Federation (№ 74-FZ of 03.06.2006) which establishes the main principle of water legislation, provides the classification of the water resources, roles of different level authorities, the main principles of water using and water protection, etc.

Furthermore, concerning the environmental protection the framework for legislation is federal law № 7-FZ **"On environment protection"** of 10.01.2002, where the main principles and mechanisms of environmental management are provided.

Federal Law № 416-FZ **"On water supply and water discharge"** establishes requirements for the composition and properties of water taken from and wastewater discharged into water bodies through centralised sewage system by organisations performing water supply and discharge service.

Resolution of the Government of the Russian Federation № 782 of 05.09.2013 **"Concerning Water Supply and Wastewater Disposal Schemes"** (including the "Regulations for the Development and

Approval of Water Supply and Wastewater Disposal Plans" and the "Requirements for the Content of Water Supply and Wastewater Disposal Plans").

Resolution of the Government of the Russian Federation № 644 of 29.07.2013 **"On the Approval of the Rules for Cold Water Supply and water discharge and Amending Certain Acts of the Government of the Russian Federation"**, in particular with regard to centralized stormwater drainage systems, establish their purpose; a ban on the intake of household wastewater and liquid household waste, other harmful substances and materials, the maximum allowable concentrations of a number of pollutants for discharge into these systems.

To improve wastewater treatment schemes and clarify technological indicators of best available technologies (BAT), Information and technical reference book (BRIEF) on the BAT **"Wastewater treatment using centralized wastewater systems in settlements, urban districts"**, was updated in 2019. The new version of the guide was approved by Order of the Federal Standard of the Russian Federation dated 12.12.2019 № 2981 and entered into force on September 1, 2020. The reference book clarified the values of technological parameters of treatment for the existing BAT and the requirements for equipping BAT for the treatment of surface wastewater. These indicators became the basis for the approval by the Government of the Russian Federation of "Technological indicators of the best available technologies in the field of wastewater treatment using centralized wastewater disposal systems in settlements or urban districts" (Resolution № 1430 dated 15.09.2020).

"Rules for classifying centralized drainage systems (sewerage) as centralized drainage systems of settlements or urban districts" (approved by Decree of the Government of the Russian Federation № 691 of 31.05.2019) establish, in particular, criteria for classifying centralized stormwater drainage systems as centralized stormwater drainage systems of settlements, urban districts (for the possibility to differ storm "household" sewer and storm sewer industrial zones).

Rules 32.13330.2018 SNiP 2.04.03-85 **"Sewerage. External networks and facilities"** (approved and enforced by the Resolution of the Ministry of Construction of Russian Federation № 860 of 25.12.2018) establishes the rules for the design of newly constructed and reconstructed drainage systems, external networks, and permanent structures for domestic and surface (rain and melt waters) effluents, as well as close to them in the composition of industrial wastewater.

"Guidelines for calculating the volume of received (discharged) surface wastewater" (approved by Order of the Ministry of Construction of Russian Federation № 639/PR of 17.10.2014). The procedure for the commercial accounting of surface wastewater received (discharged) into centralized wastewater systems is determined.

Order of the Ministry of Construction of Russian Federation № 437 of 05.08.2014 **"On approval of the requirements for the technical examination of centralized hot water supply systems, cold water supply and (or) water disposal, including determination of indicators for the technical and economic state of water supply and sanitation systems, including indicators of physical depreciation and energy efficiency of objects of centralized systems of hot water supply, cold water supply and (or) water disposal, objects of decentralized systems of cold and hot its water supply, and the procedure for monitoring such indicators"** sets the parameters for technical examination of the networks and structures of centralized wastewater systems is carried out

(deterioration of networks and structures, cleaned discharge volumes, compliance of the quality of treated stormwater with established standards, etc.).

Order of the Ministry of Construction of Russian Federation № 162 of 04.04.2014 **"On approval of the list of indicators of reliability, quality, energy efficiency of objects of centralized hot water supply systems, cold water supply and (or) water disposal, order and rules for determining planned values and actual values of such indicators"** establishes indicators of reliability and uninterrupted drainage, quality indicators for wastewater treatment, including stormwater, the procedure for determining planned indicators and actual indicators.

Order of the Ministry of Construction of the Russian Federation № 168 of 30.12.1999 **"On approval of the rules for the technical operation of systems and structures of public water supply and water discharge"** (MDK 3-02.2001) regulates the technical requirements for the operation of water supply and water discharge facilities and their compliance with sanitary standards.

Local level – St. Petersburg

Resolution of the Government of St. Petersburg № 989 of 11.12.2013 "**On approval of the water supply and water discharge scheme of St. Petersburg for the period until 2025 and perspectives until 2030**" (the scheme provides for example reconstruction and construction of treatment facilities for surface runoff; upgrade and construction of separate rainwater drainage system, etc.).

The Law of St. Petersburg № 113-23 of 13.03.2013 (with amendments from 15 February 2017) **"On the delimitation of powers of state authorities of St. Petersburg in the field of water supply and water discharge"** delimits the powers of the Legislative Assembly of St. Petersburg and the executive authorities of St. Petersburg in organizing water supply and water discharge in St. Petersburg.

Resolution of the Government of St. Petersburg № 400 **"On the Environmental Policy of St. Petersburg for the period until 2030**" of 18.06.2013 provides the main tasks for prevention of environmental and other claims caused by climate change: development of the Climate strategy of St. Petersburg; development and implementation of measures to adapt and prevent risks caused by climate change, etc.).

A working group to develop the **"Concept of Adaptive Management of Water Resources and Wastewater Systems of St. Petersburg"** was established and approved on June 24, 2016 (Order № 152-r). The working group included representatives of the authorities of St. Petersburg, SUE "Vodokanal of St. Petersburg", Neva-Ladoga Water Basin Administration of the Federal Water Resources Agency, organizations involved in water disposal and leading scientific institutes of St. Petersburg in this area. In 2017, the main sections of the Concept for Adaptive Management of Water Resources and Wastewater Systems of St. Petersburg were developed.

Order of the Committee for Energy and Engineering Support of the Government of St. Petersburg № 148 **"On the establishment of standards for wastewater in the centralized sewage systems of St. Petersburg"** of 08.11.2012 (with amendments from 6 September 2016). It establishes to water consumers of the SUE "Vodokanal of St. Petersburg" wastewater disposal standards for wastewater composition as applied to the discharge of wastewater into the centralized storm sewage system of St. Petersburg.

Annex 2. Implementation of different aspects of ISWM at national, regional and local level and generic recommendations for including these aspects

The table below summarises how different aspects of the ISWM are currently implemented in the BSR countries and provides generic recommendations how these aspects can be included in the national, regional, and local (municipal level) regulations and policies for those countries and municipalities where this has not been implemented.

Table 3. Implementation of different aspects of ISWM at national, regional and local level and generic recommendations for including these aspects.

	National level	Regional level	Local (municipality) level	Generic recommendations
Conceptual planning of the stormwater management system				
Priorities of systems design and measures	Several countries set priorities for stormwater system conceptual design at the national regulations level		In several countries priorities for stormwater system are set at the local level	Set the following priorities concerning stormwater system conceptual design (in priority order): • Runoff avoidance by use of permeable surfaces/water reuse; • Stormwater treatment and retention/infiltration on site in decentralised techniques; • Stormwater treatment and retention/infiltration using off-site centralised solutions; • Stormwater discharge into centralised separate stormwater sewer/drainage ditch system (not recommended, if only option); • Stormwater discharge into centralised combined sewer system (not recommended, if only option). Also, planning and technical guidance for sustainable stormwater management should be prepared at the national level to speed up local implementation process. Three-step approach should be addressed specifically while determining focus area in stormwater management[7]: 1) everyday rain (80% of the annual stormwater runoff) – the domain of water quality; 2) design rain – the domain of technical design of the sewer system; 3) extreme rain – the domain of resilience and public space.

[7] The three points approach, iWater project website, www.integratedstormwater.eu/toolbox/ism/three-points-approach

	National level	Regional level	Local (municipality) level	Generic recommendations
Sustainable stormwater management inclusion in spatial planning	In some countries (e.g., Finland) national level legislation explicitly requires municipalities to consider sustainable stormwater management		Most municipalities include stormwater runoff impact assessment and sustainable stormwater management provision at different scales of urban planning. Some cities (e.g., Helsinki) explicitly integrate sustainable stormwater features into green area provision (GAF)[8] In some countries (e.g., Latvia) some local municipalities (e.g., Sigulda) include sustainable stormwater management techniques as a priority in spatial planning in absence of national requirements.	Include in the national spatial regulations a requirement to consider and implement sustainable stormwater management principles in the municipal plans. Local level regulations and guidelines should be developed based on the specifics of the municipality (see 'Stormwater management programmes and guidelines;'). Conceptual guidance for such documents can be found in can beyond in iWater Tool-sheets on Local impact development and water sensitive urban design[9].

[8] The Green Area Factor tool, iWater project website, **www.integratedstormwater.eu/material/green-factor-tool**
[9] Low Impact Development (LID), Water sensitive urban design (WSUD), iWater project website, **www.integratedstormwater.eu/sites/www.integratedstormwater.eu/files/toolsheet_lid_wsud.pdf**

	National level	Regional level	Local (municipality) level	Generic recommendations
Stormwater management programme and guidelines			Typically, municipalities develop stormwater management programmes at the local level	National level regulations may mandate or provide incentives for the preparation of local stormwater management programmes at that authority level that is set as the responsible part for stormwater management. National guidelines for developing local municipality stormwater management programme/guidelines should be prepared to facilitate preparation of the programmes on the local level. Develop a local municipality stormwater management programme, based on iWater project guidelines[10]. Some examples (summaries) of local stormwater management plans included in the Annex 3.
Stormwater drainage basin management plan preparation		Regional plan (e.g., Turku and the neighbouring municipalities)	Most stormwater drainage basins plans are prepared on the local level	The need/objective for stormwater drainage basin management plans determined at national level, and guidance provided on methodology. Plans developed at regional/local level. Guidance on catchment basin plan preparation from the iWater project[11].

[10] Stormwater programmes and guidelines, iWater project website, www.integratedstormwater.eu/sites/www.integratedstormwater.eu/files/toolsheet_guidelines_strategies.pdf

[11] Cloudburst management plan, iWater project website, www.integratedstormwater.eu/sites/www.integratedstormwater.eu/files/toolsheet_cloudburstplan.pdf
Flood risk assessment and mapping, iWater project website, www.integratedstormwater.eu/sites/www.integratedstormwater.eu/files/toolsheet_floodrisk.pdf

	National level	Regional level	Local (municipality) level	Generic recommendations
Level of protection (return period of permitted stormwater flood events)	As a rule, only sewer design parameters are set at a national level. EU member states presently are working at the 2nd cycle flood risk management plans within FD implementation, where objectives may be set for stormwater flooding at a national level	Flooding objectives set at a regional level, where regional stormwater drainage basin plans are prepared (e.g., Turku and the neighbouring municipalities)	Flooding objectives are typically set together with measures at a local stormwater drainage basin level, where the approach can be most nuanced and reflect the local mix of risks, costs, benefits	Determine the optimal level of protection based on a drainage area (stormwater drainage basin) management plan. Generic guidelines: 10 years design rain for stormwater sewer design (pressure flow), 100 years flood avoiding before properties border (e.g., streets can be flooded), beyond that the risk of property owners.
System technical parameters				
Stormwater sewer design parameters	All countries, in practice return periods differ, most popular 10 years return period before water level reaches manhole top elevation (pressure flow)			10 years return period for pressure flow before water level reaches manhole top elevation or equivalent return period for gravity flow.
Combination of combined and separate system	Several countries determine limitations for the combined system at a national level (e.g., Lithuania, Finland, etc.)		In several countries limitations of the combined system are set at the local level (e.g., Latvia, Denmark)	Priority for separate system and disconnection of properties from combined system should be set at the national level. Specific policies/techniques at the local level, given local circumstances.
Technical standards for SUDS design	Several countries (e.g., Germany) have national level recommendations / standards			Technical guidance for SUDS best practice should be prepared at a national level to encourage implementation of SUDS (although strict standards may not be desirable).

	National level	Regional level	Local (municipality) level	Generic recommendations
Integrated Stormwater Management (ISWM)				
Involvement of various stakeholders into stormwater management	Some countries (e.g., Finland) determine at the national level the need for multi-sectoral working groups into the process of stormwater management planning		In some countries (e.g., Latvia, Sweden) involvement of various municipal departments is determined at the local level	National level regulation/guidance should encourage (though not mandate) the ISWM at the local level, by specifying involvement of specific stakeholders (entities responsible for urban planning, infrastructure planning, traffic planning, maintenance, water companies etc).
ISWM process regulation	The process is not regulated at the national level		Some municipalities have created manuals for ISWM	National level guidelines for ISWM Local level regulation/protocol for ISWM Generic: iWater "Integrated Stormwater Management (ISWM) system guidelines" should be used[12]
Stormwater quality				
Stormwater treatment requirements	Most countries determine the need to treat stormwater at the national level		In some country's requirements are set at a local level	At the national level, the explicit requirement for the treatment of stormwater runoff from all surfaces except for natural surfaces should be specified

[12] ISWM System guidelines, www.integratedstormwater.eu/sites/www.integratedstormwater.eu/files/iswm_guidelines_2.pdf

	National level	Regional level	Local (municipality) level	Generic recommendations
Limit values for specific pollutants	Some countries (e.g., Germany, Lithuania) set limit values at the national level		In some countries (e.g., Sweden, Latvia) limit values are set at the local level. In some countries (e.g., Finland) limit values are set at the case-by-case level, typically in the environmental permit.	Limit values should be preferably set at the local level, respecting the requirements of the specific river basin management plan and the stormwater drainage basin specifics. Considering this is a major investment in determining objectives and monitoring, generic guidance may be provided at the municipality / national level.
Monitoring procedure and frequency requirements	In some countries (e.g., Lithuania) monitoring frequency and procedures are set at the national level		In some countries (e.g., Finland) monitoring procedure and frequency requirements are set at a local level	National guidelines on monitoring procedure and frequency, with regulations decided on a local level

Annex 3. Examples of local actions plans and programmes for sustainable stormwater management

City of Helsinki Stormwater Management Programme[13]

Contents:

1. Background
2. Definition of stormwater
3. New challenges

3.1 The city becomes more dense
3.2 Climate changes
3.3 Legislation requires
3.4 City organisation develops
3.5 Stormwater quality becomes better
3.6 Urban environment benefits

4. Objectives
5. Priority order
6. Measures
7. Monitoring and reporting
8. Training and communications

The Helsinki Stormwater Management Program (further – the Program) concerns measures to be implemented by the city organisation in order to develop comprehensive stormwater management systematically, sustainably and in a long-term manner, and specifies the objectives and measures of the former stormwater strategy and takes into account the development and changes that have taken place in the urban environment.

A background of rainwater management in the City of Helsinki and a definition of stormwater is provided, and new challenges in stormwater management are identified. These are population increase, climate change, changing legislature, development of city organisation, stormwater quality and use of blue-green infrastructure in urban spaces.

The Program sets a number of objectives and a priority order for stormwater management (figure 1.1). The objectives set by the Program are the following:

- Stormwater has been utilised for increasing the attractiveness of the environment, maintaining biodiversity and promoting a good condition of surface and groundwater.

[13] City of Helsinki Storm Water Management Programme, www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/julkaisut/julkaisu-03-18-en.pdf

- Regional and local drainage has been ensured while taking the impacts of climate change into account.
- The disadvantages caused by stormwater have been prevented and eliminated in changing conditions and densifying city structure.
- Stormwater flow rates are under control and stormwater quality is improved.
- Conveying stormwater into wastewater sewer has been reduced.
- Cooperation and procedure models supporting systematic overall management of stormwater are in use, and sufficient competence and resources have been secured.

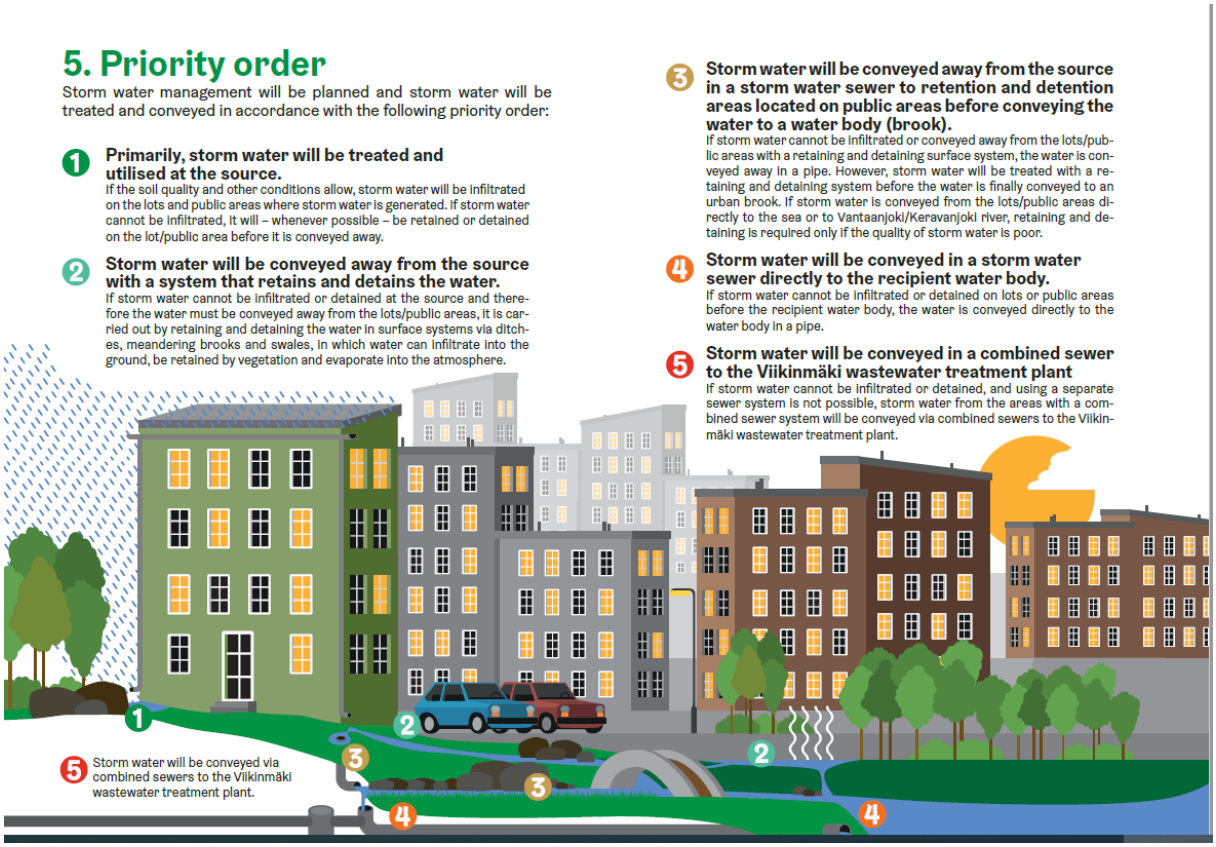
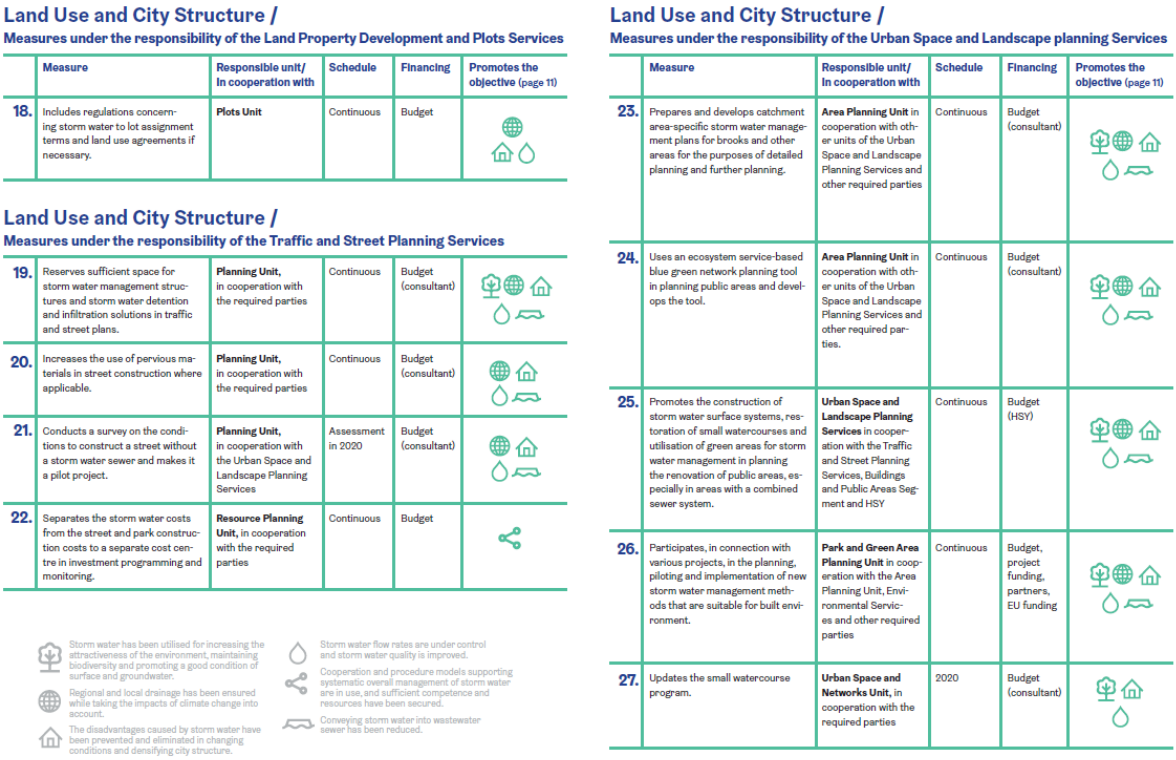


Figure 13. Excerpt from City of Helsinki Stormwater Management Program on stormwater management priorities.

Stormwater treatment priority order:

1. Treatment at the source.
2. Stormwater conveyed away from the source with a system that retains and detains the water.
3. Stormwater conveyed away from the source in a stormwater sewer to retention and detention areas located on public areas before conveying the water to a water body (brook).
4. Stormwater conveyed in a stormwater sewer directly to the recipient water body.
5. Stormwater conveyed in a combined sewer to the Viikinmäki wastewater treatment plant.



Land Use and City Structure /

Measures under the responsibility of the Land Property Development and Plots Services

	Measure	Responsible unit/ In cooperation with	Schedule	Financing	Promotes the objective (page 11)
18.	Includes regulations concerning storm water to lot assignment terms and land use agreements if necessary.	**Plots Unit**	Continuous	Budget	

Land Use and City Structure /

Measures under the responsibility of the Traffic and Street Planning Services

19.	Reserves sufficient space for storm water management structures and storm water detention and infiltration solutions in traffic and street plans.	**Planning Unit,** in cooperation with the required parties	Continuous	Budget (consultant)	
20.	Increases the use of pervious materials in street construction where applicable.	**Planning Unit,** in cooperation with the required parties	Continuous	Budget (consultant)	
21.	Conducts a survey on the conditions to construct a street without a storm water sewer and makes it a pilot project.	**Planning Unit,** in cooperation with the Urban Space and Landscape Planning Services	Assessment in 2020	Budget (consultant)	
22.	Separates the storm water costs from the street and park construction costs to a separate cost centre in investment programming and monitoring.	**Resource Planning Unit,** in cooperation with the required parties	Continuous	Budget	

Storm water has been utilised for increasing the attractiveness of the environment, maintaining biodiversity and promoting a good condition of surface and groundwater.

Regional and local drainage has been ensured while taking the impacts of climate change into account.

The disadvantages caused by storm water have been prevented and eliminated in changing conditions and densifying city structure.

Storm water flow rates are under control and storm water quality is improved.

Cooperation and procedure models supporting systematic overall management of storm water are in use, and sufficient competence and resources have been secured.

Conveying storm water into wastewater sewer has been reduced.

Land Use and City Structure /

Measures under the responsibility of the Urban Space and Landscape planning Services

	Measure	Responsible unit/ In cooperation with	Schedule	Financing	Promotes the objective (page 11)
23.	Prepares and develops catchment area-specific storm water management plans for brooks and other areas for the purposes of detailed planning and further planning.	**Area Planning Unit** in cooperation with other units of the Urban Space and Landscape Planning Services and other required parties	Continuous	Budget (consultant)	
24.	Uses an ecosystem service-based blue green network planning tool in planning public areas and develops the tool.	**Area Planning Unit** in cooperation with other units of the Urban Space and Landscape Planning Services and other required parties.	Continuous	Budget (consultant)	
25.	Promotes the construction of storm water surface systems, restoration of small watercourses and utilisation of green areas for storm water management in planning the renovation of public areas, especially in areas with a combined sewer system.	**Urban Space and Landscape Planning Services** in cooperation with the Traffic and Street Planning Services, Buildings and Public Areas Segment and HSY	Continuous	Budget (HSY)	
26.	Participates, in connection with various projects, in the planning, piloting and implementation of new storm water management methods that are suitable for built environment.	**Park and Green Area Planning Unit** in cooperation with the Area Planning Unit, Environmental Services and other required parties	Continuous	Budget, project funding, partners, EU funding	
27.	Updates the small watercourse program.	**Urban Space and Networks Unit,** in cooperation with the required parties	2020	Budget (consultant)	

Figure 14. Excerpt from City of Helsinki Stormwater Management Program on measures and responsible parties.

The Program lists the necessary measures in stormwater management, the responsible agencies, schedule of development, and methods of financing, as well as identifies which objectives are promoted by each measure. A brief discussion of he required monitoring and training is given.

The City of Copenhagen Cloudburst Management Plan 2012[14]

Contents:

1. Introduction
2. Recommendations
3. Upgrading City Resilience to Extreme Rainfall Events
3.1 Recommendations of the Climate Adaptation Plan
3.2 Methods of Implementing Adaptive Measures in Copenhagen
3.2.1 Draining stormwater out to Sea
3.2.2 Storage of stormwater
3.3 The Contribution of Flood Risk Management Initiatives to a Blue-Green City Infrastructure
4. The level of Flood-Proofing Required for Copenhagen
4.1 Water levels During Flooding
4.2 Background to Risk Dimensioning
4.3 Recommendations for Risk Dimensioning
5. Order of Priority
5.1 Dividing and Prioritising the City into Water Catchment Areas
6. Legislation, Responsibility, and Financing
6.1 Proposal for Amendments
6.2 Methods of Financing
6.3 Total Investments
6.4 Allocation of Responsibility
7. Emergency Response Plan
8. Position in Relation to Other Planning Activities
9. Next Phase

The introductory section of the City of Copenhagen Cloudburst Management Plan (further – the Plan) contains an overview of the current and projected future situation in Copenhagen regarding extreme rainfall events and stresses the need for coordinated action. Measures initiated previously included the Copenhagen Climate Adaptation Plan (adopted 25 August 2011), which sets the framework for the implementation of climate adaptive measures in the City Administration area. As an offshoot of this, the Plan outlines the methods, priorities, and measures recommended for the area of climate adaptation including extreme rainfall, as well as flooding caused by storm surges forcing sea water inland.

The Plan contains general and specific recommended measures, which must be taken in order to deal with future extreme rainfall events and to upgrade the city's resilience to extreme rainfall events by implementing adaptive measures – the draining of stormwater out to sea and the storage of stormwater. The city plans to increase the presence of blue-green infrastructure, although it is noted

[14] City of Copenhagen Cloudburst Management Plan 2012, https://en.klimatilpasning.dk/media/665626/cph_-_cloudburst_management_plan.pdf

that the quantities of water that must be handled would be too large to transport exclusively at ground level, and a combination of blue-green infrastructure and tunnels is suggested.

As there is always a possibility of greater quantities of water produced by rainfall than the system is prepared for regardless of how comprehensive it is, the Plan defines what water level is acceptable during floods. On roadways the acceptable water level is set at 10 cm, as this level still allows use of roads by car, bicycle or foot and mostly prevents water from entering basements. A cost-benefit analysis was used to determine that the greatest socio-economic gains would be achieved by implementing measures against 1 in 100 events (figure 2.1), however benefits would be experienced in both smaller and larger risk dimensioning as well. Overall, the Plan recommends that sewer discharge be allowed to reach ground level once every 10 years, and average water levels be allowed to exceed ground level by 10 cm once every 100 years, excepting areas specifically designated for flood control storage.

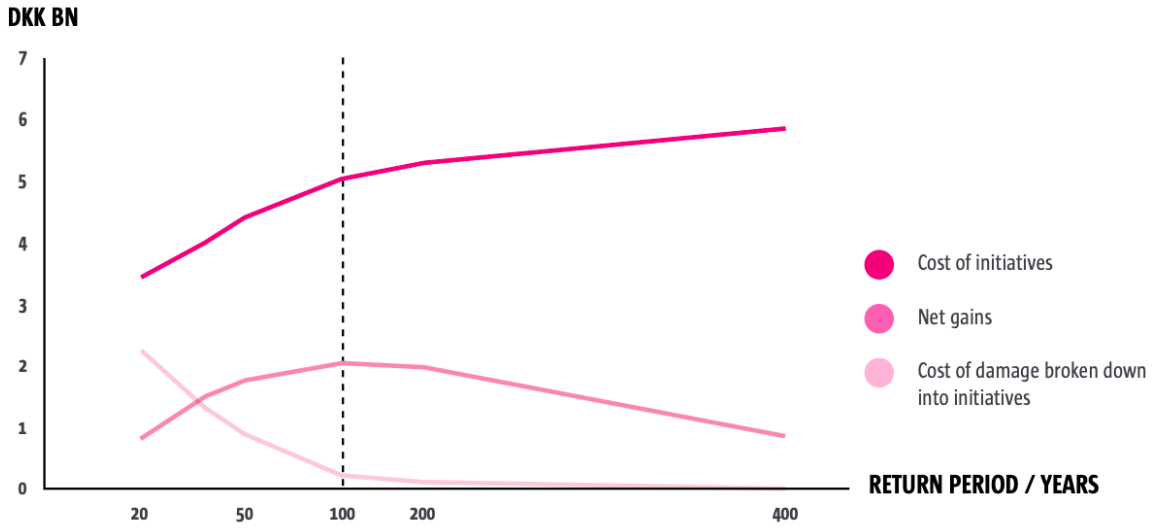


Figure 15. Net gains from flood defence measures in Frederiksberg and the City of Copenhagen. The amounts are present-day values over a period of 100 years.

To determine the order of priority of adaptive measures, the Plan divides Copenhagen into 26 water catchment areas based on flow routes (figure 2.2) which were assessed according to four elements (risk, implementation, coherence with urban development projects and synergistic effect) and ranked by priority. The present legislation and methods of financing is discussed, and amendments are suggested where appropriate; the players identified by the plan as responsible for increasing city resilience against flooding are property owners, the utility company, and the City Administration.

Figure 16. Copenhagen flow routes.

The flow routes start at the point where the lines are thin and become thicker proportional to the quantities of water flowing into them.

Finally, an emergency response plan, the position of the Plan in relation to other planning activities and the needed further steps are discussed.

Stockholm Stormwater Strategy[15]

Contents:

1. Introduction
2. Background and purpose
3. Challenges in a growing city
4. Sustainable stormwater management
5. Goals for sustainable stormwater management

5.1 Improved water quality in the city's water
5.2 Robust and climate-adapted stormwater management
5.3 Resource and value creation for the city
5.4 Environmentally and cost-effective implementation

6. Responsibility for implementing the strategy

The Stockholm Stormwater Strategy (further – the Strategy) replaces the "Stormwater Strategy for the City of Stockholm", which was adopted by the City Council in 2002 and which was updated in 2005.

The Strategy aims to develop the city's stormwater management towards a more sustainable approach by focusing on water quality, highlighting principles for utilizing stormwater and dealing with the challenges that arise through climate change in an increasingly denser city.

The Strategy gives an overview of the history of stormwater management in Stockholm and precipitation data and describes the existing infrastructure and facilities. Future challenges are identified: population growth and increasing population density, water pollution and eutrophication, climate change bringing more rainfall and more heat waves, a longer vegetation period and rising sea level.

The Strategy sets a number of goals for sustainable urban stormwater management:

- Improved water quality: the stormwater management will contribute to an improvement of the city surface and groundwater quality so that good water status or equivalent water quality can be achieved in all the city's water areas;
- Robust and climate-adapted stormwater management: stormwater management must be adapted to changing climactic conditions with increased annual rainfall, more intense rainfall events and elevated water levels in lakes, coastal waters and streams;
- Creation of resources for the city: stormwater is part of the water cycle in the city and should be used as a resource to create attractive and functional elements in the urban environment;

[15] Stockholm Stormwater Strategy, http://miljobarometern.stockholm.se/content/docs/vp/Stockholms_dagvattenstrategi_2015-03-09.pdf

- Cost-effective implementation: to achieve the goal of sustainable stormwater management, the issue needs to be considered in all stages of the urban building process in parallel with systematic action planning. An important prerequisite is consensus, coordination and a well-thought-out division of responsibilities between the city's administration and companies.

Principles for achieving these goals, areas of special focus and the responsible agencies are also identified within the Strategy.

Växjö Climate Change Adaptation Plan 2013[16]

Contents:

1. Background and Implementation
1.1 Climate and Vulnerability Report SOU 2007: 60
1.2 County Administrative Board
1.3 Purpose and Objectives
1.4 Organisation and Method
1.5 Climate Basis
1.6 Definitions
2. Role of the Municipality and the Current Situation
2.1 The EU Project CLIPART
3. Climate change in Växjö Municipality
3.1 Climate Change Factors Affecting Växjö Municipality
3.2 Climate Impact Profile
4. Impact of a Changed Climate – Threats and Opportunities
4.1 Infrastructure
4.2 Housing
4.3 The Natural Environment, Agriculture and Tourism
4.4 Human Health
5. Needed Measures, Responsibility and Priority of Measures

Växjö Climate Change Adaptation Plan (further – the Plan) includes a detailed discussion of the expected effects of climate change on the Växjö municipality, the opportunities and threats posed by climate change, including on infrastructure, housing, the natural environment, and human health. The necessary measures for management of the effects of climate change are defined and the responsible parties identified.

The purpose of the Plan is to mitigate the negative impacts and costs but also seize new opportunities associated with climate change. The goals if the Plan are to identify the areas where additional measures are required to be better equipped for future climate and to integrate climate adaptation into the municipality's daily processes and planning in order to contribute to sustainable development.

The Plan identifies those climate change factors which are likely to affect the municipality in the future – increased annual temperature, milder winters, increased annual and seasonal rainfall (mainly in winter), heavy rainfall events, prolonged dry periods, increased evaporation, changes in groundwater levels, changes in water flows, higher risk of extreme rainfall events (with 1 in 100

[16] Växjö Climate Change Adaptation Plan 2013, https://vaxjo.se/download/18.313cf36515d1bde9ee322708/1499862673573/Klimatanpassningsplan%20f%C3%B6r%20V%C3%A4xj%C3%B6%20kommun.pdf

events becoming 20% more likely by the end of the century), changes in the vegetation period and frost period, more extreme winds.

Climate change management measures are prioritized based on urgency and broken down by area of responsibility. Four measures received highest priority:

- develop investment plans for stormwater operations;
- make visible in The Green Structure Program and in regular planning work areas that are important from an urban heating and stormwater perspective;
- develop an action plan to maintain normal indoor temperature (mainly for vulnerable groups such as children, elderly and ill persons) at high outdoor temperatures;
- complete an inventory of calculated maximum flow and develop guidelines for future development.

These and other identified management measures are divided by responsibility between the municipality, as well as the technical, school, care services, city planning, environmental and health protection, culture and recreation, child protection, and corporate agencies.