Water recycling strategy - summary
Kurzeme Region

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Pasūtītājs:
Kurzemes plānošanas reģions
Reģ. Nr. 90002183562
Adrese: Avotu iela 12, Saldus, LV-3801
Birojs: Valguma iela 4A,
Rīga, LV-1048
e-pasts: pasts@kurzemesregions.lv

PĒTĪJUMS:

“Lietus ūdens atkārtota izmantošana Kurzemes reģiona pašvaldībās”

Kopsavilkums angļu valodā

Konsultants:
Jurijs Kondratenko, SIA „D-0”
Reģ. Nr.: 40103176940
Adrese: Vairoga 39-3, LV-1039, Rīga
Telefons: +371 28349594,
E-pasts: d0-info@inbox.lv

Kontakti:
Jurijs Kondratenko,
+37128349594
yurikondratenko@inbox.lv

Satura rādītājs

1 Introduction

Climate change and the associated fluctuations in weather patterns are increasingly affecting the availability and quality of water resources in Latvia, including in the Kurzeme region. Projections indicate that in the future, the distribution and intensity of precipitation will change – heavy rainfall events are expected to become more frequent, while the risks of flooding and drought will increase. Under such conditions, the reuse of rainwater becomes an essential component of a sustainable water management strategy, as it can simultaneously reduce flood risks and provide additional water resources for various economic needs.

Currently, rainwater management in the municipalities of Kurzeme is primarily focused on drainage through sewerage systems, while its reuse has not yet been widely implemented in practice. This highlights the need to improve infrastructure, legal frameworks, and public awareness in order to promote rainwater as a valuable resource for both the public and private sectors. The aim of this study is to identify existing trends, the most suitable solutions, and development opportunities for rainwater reuse in the Kurzeme region.

The study analyses historical and projected climate and precipitation trends in the Kurzeme planning region, evaluates rainwater quality requirements in the context of the European Union and other countries, summarizes the principles and practices of sustainable rainwater management, and reviews relevant regulatory frameworks and planning documents. It also provides an overview of municipal initiatives and identifies areas affected by short-term flooding. Data were obtained through a combination of literature and legislative analysis, as well as workshops and surveys, ensuring both quantitative and qualitative insights into the potential for rainwater reuse in the Kurzeme region.

2 Past Trends and Future Projections in the Kurzeme Planning Region

Based on data from the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report, three climate change scenarios have been applied for Latvia: SSP1-2.6 (low change), SSP2-4.5 (moderate change), and SSP3-7.0 (significant change). Future models predict a steady rise in average air temperature throughout the 21st century, exceeding the +2°C threshold relative to the climatological reference period (1961-1990) as early as 2021-2050. With rising temperatures, winter precipitation is expected to fall more frequently as rain rather than snow, thereby increasing winter runoff and the need for greater rainwater collection capacity. At the same time, longer heatwaves and extended growing seasons will increase the demand for water used in irrigation and cooling.

In the event of significant climate change, the number of frost days is projected to decrease by approximately 70 days by the end of the century, while the vegetation period will lengthen by 30 to 66 days, particularly along the Kurzeme coast. These changes imply a longer growing and irrigation season, increasing the need for a stable year-round water supply.

Sea level rise is another critical factor that will affect the Kurzeme coastline. Projections suggest that by 2100, sea level in Latvia could rise by 53 to 71 centimetres, depending on the scenario. This will heighten the risk of flooding and coastal erosion, affect groundwater quality and coastal ecosystems, and pose risks to freshwater availability and agricultural development.

Climate change is also expected to increase the total annual precipitation. During the climatological reference period (1961-1990), the average annual precipitation in Latvia was 656 mm, whereas during the most recent period (1991-2020) it increased to 685 mm. Future projections indicate a further rise in precipitation by 18-24%, depending on the scenario, with the greatest increase expected during winter.

The number of days with heavy precipitation is also projected to rise – from 18 days per year under low climate change to 22 days under significant change. Precipitation intensity on wet days is expected to reach approximately 5.7 mm. These trends highlight the need for efficient rainwater collection and storage infrastructure to mitigate short-term flooding risks and to enable the use of rainwater for economic purposes during drier periods.

Overall, the findings confirm that climate change will have a substantial impact on water resources in the Kurzeme region; therefore, the implementation of rainwater reuse measures represents a crucial step toward sustainable water management.

3 Quality Requirements for the Use of Rainwater in the Public and Economic Sectors

This section summarizes the requirements established by the European Union, the Republic of Latvia, and selected international guidelines concerning the use of rainwater in the public and economic sectors.

3.1 European Union Regulation

Regulation (EU) 2020/741 of the European Parliament and of the Council (adopted on 25 May 2020) establishes the minimum requirements for the safe reuse of treated water. The Regulation emphasizes that wastewater reuse represents an environmentally friendly alternative to the abstraction of new water resources or desalination. Member States are required to develop risk management plans to protect public health and drinking water sources, as well as to ensure public awareness of the benefits of water reuse.

According to Regulation (EU) 2020/741, reclaimed water refers to urban wastewater treated in accordance with the requirements of Directive 91/271/EEC and subjected to additional treatment to ensure its safe use. Such water may be used for agricultural irrigation, both for food and non-food crops, as well as for industrial and municipal purposes. The Regulation also allows Member States to define additional uses, provided that environmental and health protection requirements are met.

3.2 European Standard EN 16941

In addition to the Regulation, European Standard EN 16941 provides guidelines for local non-potable water systems that utilize rainwater or treated greywater in buildings and on their premises. The standard is designed to reduce potable water consumption and promote sustainable water resource management.

Part 1 of the standard, EN 16941-1:2024, regulates the use of rainwater for non-potable purposes such as toilet flushing, cleaning of outdoor areas and vehicles, irrigation of green spaces, and industrial applications. Systems must ensure water collection from safe surfaces, diversion of the initial runoff, filtration, and secure storage. They must comply with labelling requirements (“non-potable water”) and be subject to regular maintenance, including tank cleaning and water quality monitoring.

Part 2, EN 16941-2:2021, addresses the use of treated greywater. Both parts are based on a risk management approach and apply the “fit-for-purpose” principle, which stipulates that the level of treatment must correspond to the intended use and the potential risk of human contact with the water.

3.3 International Experience

The Australian Guidelines for Water Recycling (AGWR) provide a scientifically grounded framework defining principles for health risk assessment and microbiological safety. These guidelines stipulate that the health risk from reused water should not exceed 10^{-6} DALY per year (approximately one illness per 1,000 people). Depending on the intended use of the water, specific pathogen reduction targets (log reduction values) are established to ensure adequate protection of human health.

The State of California’s regulatory framework imposes strict requirements on rainwater reuse. Rainwater may be used for non-potable purposes, such as toilet flushing, laundry, or irrigation, if it meets specific quality criteria (e.g., E. coli < 100 CFU/100 ml and turbidity < 10 NTU). For potable use, additional treatment is required to achieve at least a 3-4 log reduction in pathogens and turbidity below 0.3 NTU. Such systems must be separated from the public water supply network and designed to prevent cross-contamination.

In summary, both European and international standards emphasize the importance of risk management, water quality monitoring, and public health protection, ensuring that rainwater reuse is implemented safely and sustainably.

4 Principles and Solutions for Sustainable Rainwater Management

This section outlines the key principles, planning approaches, and main types of solutions for sustainable rainwater management that ensure effective stormwater control, pollution reduction, and enhancement of urban ecological quality. Particular emphasis is placed on the integration of nature-based solutions into urban infrastructure, promoting water resource conservation, biodiversity, and climate resilience. The section further examines the environmental, operational, and economic advantages of rainwater reuse in comparison with combined sewer systems, and analyses how rainwater quality varies across different land-use contexts.

4.1 Core Principles of Sustainable Rainwater Management

The primary goal of Sustainable Rainwater Management (SRM) is to ensure the safe and efficient collection, conveyance, and use of stormwater while reducing flood risks and improving urban ecological conditions. SRM helps alleviate pressure on sewerage networks and treatment plants, fosters biodiversity, and enhances the quality of public spaces.

SRM is based on the principle that urban environments should emulate natural hydrological processes. It includes solutions that allow rainwater to infiltrate, be retained, or reused on-site, such as rain gardens, swales, infiltration fields, ponds, green roofs, and permeable surfaces.

The hierarchy of sustainable management typically follows this order:

1. Reduction of runoff through permeable surfaces and rainwater reuse;
2. On-site treatment and infiltration (decentralized solutions);
3. Centralized treatment systems outside the site;
4. Discharge into a separate stormwater sewer;
5. Discharge into a combined sewer system.

4.2 Planning of Sustainable Rainwater Management

In urban areas, SRM planning requires an integrated approach that combines principles of urban planning, engineering, landscape architecture, and environmental management. The goal is to develop systems that maintain water quality while also enhancing aesthetic and ecological values.

Depending on scale, SRM solutions can be grouped as follows:

- Point-scale solutions: green roofs, permeable pavements, infiltration trenches;
- Local-scale solutions: retention basins, swales, drainage ditches;
- Regional-scale solutions: ponds or constructed wetlands that integrate multiple local systems.

When designing SRM measures, factors such as geological and hydrological conditions, groundwater level, land use, existing infrastructure, and flood pathways must be considered. Design processes should aim to promote biodiversity and integrate SRM elements into the urban landscape, creating visually attractive and functional public spaces.

Green and blue infrastructure elements provide habitats for local flora and fauna, while the use of diverse plant species helps maintain ecological balance and improve the urban microclimate.

4.3 Main Types of Sustainable Rainwater Management Solutions

Retention ponds are permanent water bodies designed for stormwater retention, sedimentation, and biological treatment. They can also serve important landscape and recreational functions.

Ditches and swales facilitate water conveyance and infiltration while reducing flood risks. Swales are typically shallow, vegetated depressions that filter and treat runoff. Bio-swales combine natural and engineered filtration structures, such as drainage pipes or geotextile layers, to prevent groundwater contamination.

Rain gardens are small-scale systems composed of vegetation and soil layers that capture and treat stormwater through biological processes. They are commonly used in residential areas or low-traffic streets.

Constructed wetlands employ natural processes to remove pollutants by combining water flow and vegetation effects. They are resilient to variable hydraulic loads and suitable for both stormwater and wastewater treatment.

Infiltration systems (e.g., wells, trenches, fields, or basins) enable groundwater recharge and sedimentation of pollutants. These are suitable for green spaces and infrastructure areas with significant surface runoff.

Permeable pavements (e.g., eco-pavers, porous asphalt) allow water to infiltrate through the surface, reducing runoff and improving the functionality of urban areas. Such solutions are particularly useful in densely built environments with limited space for other SRM elements.

Green roofs promote rainwater retention and evaporation, mitigate the urban heat island effect, and improve building energy efficiency. Extensive roofs require minimal maintenance, while intensive rooftop gardens offer a wider variety of vegetation and recreational use.

In summary, sustainable rainwater management solutions provide a comprehensive approach to urban water governance, combining engineering, ecological, and aesthetic dimensions to foster resilient, climate-adaptive, and sustainable urban environments.

4.4 Reuse of Rainwater Compared with Combined Sewer Systems

The reuse of rainwater significantly reduces pollutant loads discharged into aquatic environments. Overflows from combined sewer systems can contribute up to 95% of the annual river pollution from domestic contaminants such as pharmaceuticals, polycyclic aromatic hydrocarbons, hormones, and urban pesticides. Moreover, groundwater quality may be adversely affected by infiltration and contamination processes associated with conventional drainage systems.

Improved surface water quality resulting from rainwater reuse is essential for protecting environmental and public health, while also supporting fisheries and tourism, which are important economic sectors. In addition, reduced dilution and lower wastewater volumes enhance the efficiency of wastewater treatment plants, decrease pollutant loads, increase operational flexibility, and reduce maintenance costs.

Decentralized rainwater management solutions, such as infiltration basins, lower the need for major investments in regional water infrastructure expansion and improve the climate resilience of water supply, sewerage, and wastewater treatment systems. Furthermore, optimized wastewater flow management enables the recovery of thermal energy, contributing to reduced overall energy consumption.

4.5 Rainwater Quality and Reuse Potential in Different Land-Use Areas

Rainwater quality varies substantially depending on land use. On **roads and highways**, runoff typically contains oils, heavy metals, hydrocarbons, and rubber particles originating from vehicle wear and fuel leaks. These pollutants can be toxic to aquatic organisms and accumulate in sediments. After advanced treatment involving sedimentation, oil separation, filtration, and disinfection, such water may be reused in a limited manner, though not for food crop irrigation.

In **parking lots and industrial areas**, petroleum products, metals, detergents, and solid waste dominate the pollutant profile. These substances may cause oxygen depletion, water toxicity, and aesthetic degradation. Treated runoff is suitable only for restricted irrigation of non-food vegetation.

Residential areas generate runoff containing nutrients, pesticides, detergents, and animal waste, mainly from lawn care, car washing, and pet activity. This can lead to eutrophication, algal blooms, and pathogen contamination. With adequate filtration and disinfection, such water is appropriate for garden and lawn irrigation.

Commercial zones produce runoff rich in food waste, fats, and cleaning agents, which can reduce dissolved oxygen and cause odor problems. After sedimentation, grease removal, filtration, and disinfection, reuse is limited to non-food-related irrigation.

Construction site runoff is characterized by high sediment loads, alkaline concrete wash water, and debris, primarily due to soil erosion and building activities. Because of unstable pH and high suspended solids, this water is generally unsuitable for reuse.

Agricultural runoff contains nutrients, pesticides, and animal waste from fertilizer application and livestock farming. These contaminants contribute to eutrophication and bacterial pollution. Treated water may be reused cautiously for irrigation, avoiding direct contact with food crops.

Roof runoff mainly contains debris, metals, and bird droppings from roofing materials and atmospheric deposition. With first-flush diversion, filtration, and disinfection, it is well suited for landscaping, green roofs, and toilet flushing.

Urban open spaces, such as parks and sports fields, produce runoff enriched with fertilizers, herbicides, organic matter, and pathogens. After biofiltration, sand filtration, and disinfection, this water is ideal for landscape irrigation.

In **port and marina areas**, runoff is contaminated with oils, paints, and heavy metals from vessel maintenance and fuel spills. Due to the persistence and toxicity of these pollutants, reuse is not recommended even after treatment.

5 Planning Documents and Legal Framework for the Development of Sustainable Rainwater Management

This chapter compiles Latvian and European Union planning documents and legal acts that regulate rainwater management. These instruments define strategic objectives, technical requirements, and legal mechanisms for sustainable, climate-resilient, and environmentally sound rainwater governance, promoting a shift towards green infrastructure and resource reuse.

5.1 Overview of National Development Planning Documents and Legal Acts

The Environmental Policy Guidelines 2021-2027 set out Latvia’s environmental policy objectives, including the transition from traditional (grey) infrastructure to sustainable, nature-based solutions. In the field of rainwater management, the Guidelines emphasize the introduction of green infrastructure to reduce flood risk, ensure water treatment, and improve urban living conditions.

The document establishes specific targets to be achieved by 2027: increasing access to green infrastructure for 18,000 inhabitants, improving flood protection for more than 194,000 inhabitants, creating 60 ha of new green infrastructure, and increasing water reuse in enterprises to 20%.

The lines of action include adaptation to climate change, flood risk management, improvement of rainwater regulation, and the promotion of rainwater use in households and the wider economy.

The Latvian Climate Change Adaptation Plan up to 2030 aims to strengthen the capacity of the state and municipalities to respond to climate risks. It highlights the need to adapt urban areas to increasing precipitation intensity by developing green infrastructure and modernising drainage systems. Strategic objectives focus on the creation of climate-resilient infrastructure and the protection of economic resources. The plan includes measures to increase the capacity of stormwater systems, implement flood modelling, develop guidelines, and adapt buildings and structures to climate-related loads.

The Water Management Law provides for the preparation of river basin management plans to ensure good ecological status and effective flood risk management. It requires the assessment of flood risks, the development of flood risk maps, and the involvement of the public in the preparation of these documents.

The Law "On Environmental Impact Assessment" lays down the procedures for assessing proposed activities and development projects in order to prevent adverse environmental effects. In the context of water management, this law ensures that construction and infrastructure projects are also evaluated in terms of their potential impact on water resources.

The Environmental Protection Law establishes the obligation to reduce pollution and promote the sustainable use of natural resources. It provides for the development of environmental technologies and eco-innovation, as well as voluntary environmental management instruments to support efficient resource use.

The Land Reclamation Law regulates the maintenance and operation of individual and shared drainage systems, defining the responsibilities of landowners and municipalities. It also points to practical challenges regarding municipal capacity to maintain shared systems located on private land, while stressing the need to find an appropriate legal solution.

The Water Services Law stipulates that the discharge of rainwater into a combined sewerage system constitutes a public service, whereas the management of separate stormwater systems does not. Municipalities are authorised to adopt binding regulations on rainwater management and to ensure an integrated approach to the governance of municipal wastewater and stormwater.

Cabinet Regulations further specify the national legal framework for rainwater management. They define emission limits for pollutants in water (No. 34), quality standards for surface and groundwater (No. 118), the procedures for the provision of public water services (No. 174), as well as construction standards on climatology (LBN 003-15), sewerage structures (LBN 223-15), and drainage and hydrotechnical structures (LBN 224-15). Taken together, these documents regulate the technical, environmental, and financial requirements for rainwater collection, conveyance, and treatment.

5.2 Overview of European Union Legal Acts

The Water Framework Directive (2000/60/EC) lays down requirements for achieving good ecological status in all water bodies and for the preparation of river basin management plans. The Directive emphasizes pollution reduction, particularly from surface runoff and rainwater.

The Floods Directive (2007/60/EC) requires flood risk assessment across the entire territory, the development of flood hazard and risk maps, and the preparation of flood risk management plans for each river basin district, integrating these measures with water management planning.

Directive 91/271/EEC concerning urban wastewater treatment establishes the obligations of Member States to limit pollution from urban wastewater, including combined sewer overflows during heavy rainfall events, in order to prevent eutrophication. It does not, however, apply to rainwater that has not been mixed with domestic wastewater.

EU Regulation 2020/741 sets minimum requirements for the reuse of treated water, particularly in agriculture, with the aim of reducing water scarcity risks and promoting the sustainable management of water resources. It defines quality standards, risk management requirements, and monitoring criteria for reclaimed water.

6 Rainwater in the Water Balance of Municipalities and Water Utilities in the Kurzeme Region

This section examines the role of rainwater in the water balance of municipalities and water utility companies in the Kurzeme region. It analyses the extent to which rainwater contributes to total wastewater volumes, highlighting substantial spatial differences largely influenced by reporting practices. The section also identifies seasonal patterns, with increased wastewater flows in winter. Furthermore, it demonstrates that stormwater and infiltrated groundwater account for a significant share of wastewater treatment volumes and costs, underscoring the economic and operational importance of effective rainwater management in the region.

6.1 Rainwater in the Water Balance of Municipalities

In several municipalities of the Kurzeme region, rainwater constitutes a substantial share of total water abstraction. For instance, in Liepāja in 2024, 2.68 million m³ of rainwater were abstracted, representing 32% of the total water withdrawn from natural sources. In contrast, rainwater abstraction was negligible in Talsi, Kuldīga, and Saldus municipalities. These differences largely reflect variations in reporting practices related to the “Water-2” statistical form, as not all institutions responsible for stormwater management submit these reports. Typically, only entities involved in water abstraction and treatment provide data, whereas municipal services managing stormwater drainage often do not. Consequently, the actual volumes of managed rainwater are likely higher than reported. Overall, the data indicate that stormwater plays a significant role in municipal water balances and associated management costs.

Across all Kurzeme municipalities, discharged wastewater is dominated by compliant wastewater with or without treatment. In 2024, only small volumes of non-compliant wastewater with treatment were reported in Dienvidkurzeme, Kuldīga, and Saldus, while untreated non-compliant wastewater was virtually absent. The largest stormwater discharges occurred in Ventspils (252,000 m³; 8% of total wastewater) and Liepāja (161,000 m³; 2%), with Dienvidkurzeme reporting 63,000 m³ (5%).

6.2 Seasonal Variations in the Water Balance of Water Utilities

Seasonal trends are evident in water abstraction by Kurzeme water utilities, with peak volumes in late spring and summer, especially in July, and the lowest levels in autumn and early spring. Even stronger seasonality is observed in wastewater discharges. In 2024, the highest volumes occurred in winter, particularly in February, exceeding summer and early autumn levels by more than twofold. This increase is mainly attributable to stormwater and infiltrating groundwater.

The difference between abstracted water and wastewater conveyed to treatment plants, comprising stormwater, drainage water, and infiltrated groundwater, accounts on average for 40-50% of total wastewater volumes. This indicates that nearly half of wastewater treatment costs are associated with non-sanitary water flows. The figures below present the reported stormwater volumes for 2024 and the corresponding water service tariffs (including VAT), which in several municipalities approach or exceed EUR 2 for water supply and EUR 5 for combined services.

7 Overview of Existing and Planned Rainwater Management Measures

This section provides an overview of existing and planned rainwater management measures included in sustainable development strategies, development programmes, investment plans, and work plans, as well as implemented rainwater management projects (both capacity-building/planning and investment projects) in the municipalities of the Kurzeme region.

On the basis of the current situation and the analysis of planning documents, it formulates development recommendations for the region, municipalities, and other stakeholders, and concludes by identifying typical investment-plan project types where sustainable rainwater management, including nature-based solutions and rainwater reuse, can be integrated.

7.1 Rainwater Management in Kurzeme Municipalities

In **Dienvidkurzeme Municipality**, the Sustainable Development Strategy emphasizes consideration of flood risks in tourism and settlement planning, while the Development Programme (2022-2027) prioritizes climate adaptation under the “Green, Smart and Accessible Liepāja and DKN” objective. Implemented projects include conventional stormwater drainage works in Aizpute and an ERDF-funded system upgrade in Priekule, which introduced wetland-based retention and infiltration. Further stormwater infrastructure development is underway in Pāvilosta, with plans to integrate sustainable and rainwater reuse solutions.

Kuldīga Municipality’s Sustainable Development Strategy (2022-2046) prioritizes phased stormwater infrastructure provision, green infrastructure, water quality protection, and flood-risk reduction. The Development Programme and the Sustainable Energy and Climate Action Plan (SECAP) promote drainage system restoration, separation of stormwater from domestic sewerage, and the use of rainwater for non-potable purposes. Implemented projects include street reconstructions with stormwater networks, installation of an oil separator, and an ERDF-funded project in Skrunda involving stormwater system expansion and pond naturalisation for retention and auxiliary water uses. Additional flood-risk mitigation projects are planned.

In **Liepāja State City**, the Sustainable Development Strategy to 2035 and the Development Programme (2022-2027) highlight climate adaptation, flood protection, and sustainable water management. The SECAP (2023-2030) focuses on upgrading drainage systems and restoring natural watercourse capacity. Between 2021 and 2025, over 60 street reconstruction projects expanded stormwater infrastructure. An ongoing ERDF project in the South-Western neighbourhood integrates water body rehabilitation, green infrastructure, flood-risk reduction, and inclusive public-space design, with reuse of dredged sediments for urban landscaping.

Saldus Municipality's Sustainable Development Strategy does not address stormwater management directly, but the Development Programme (2022-2028) supports modernization of water, sewerage, and stormwater networks, drainage system adaptation, and urban greening. The SECAP (2020-2030) notes the need to reduce stormwater inflow into domestic sewer systems. Recent projects include rainwater storage tanks for irrigation and additional retention capacity under construction, with possible future ERDF applications.

In **Talsi Municipality**, stormwater management is not covered in the Sustainable Development Strategy, while the Development Programme (2022-2028) promotes climate-resilient measures and green infrastructure to reduce flood risk. Implemented actions have mainly focused on storm sewer construction, and the municipality is considering participation in the ERDF climate adaptation programme.

Tukums Municipality's Sustainable Development Strategy (2022-2042) explicitly supports climate adaptation through sustainable stormwater and flood protection solutions, including rainwater collection and reuse systems. The Development Programme broadly promotes green infrastructure, although the SECAP does not address stormwater issues. Recent projects focus on improving stormwater conveyance, particularly near the railway, and planned ERDF applications aim to introduce rain gardens, infiltration systems, and tree-planting with rainwater storage in the city centre.

In **Ventspils Municipality**, the Joint Sustainable Development Strategy with Ventspils State City prioritizes resilient, environmentally friendly infrastructure and green-blue solutions for flood-risk reduction. Although the Joint Development Programme does not address stormwater management, substantial investment has been made in drainage system rehabilitation across several settlements, including Blāzma and Piltene, with further ERDF applications under consideration.

Ventspils State City's SECAP (2023-2030) emphasizes adapting infrastructure to changing rainfall patterns, increasing stormwater storage capacity, and reducing flood risk by at least 5%. Recent projects include stormwater collector rehabilitation and an ERDF-funded initiative combining drainage system reconstruction with urban greening, including tree planting supported by irrigation systems that partially rely on harvested rainwater.

7.2 Recommendations for Planning Documents

Kurzeme municipal planning documents should integrate stormwater management and rainwater use across development, spatial, SECAP, and greening plans. These documents should assess climate risks from extreme rainfall, heat, drought, and erosion, and define coordinated mitigation and adaptation measures, supported by mapping of flood- and heat-prone areas.

Planning frameworks should prioritize sustainable, nature-based, and decentralized stormwater solutions. Climate risk assessments should guide decision-making, while collaborative planning processes can support effective integration into official documents. Strategic plans should include clear climate indicators and objectives focused on reducing flood and heat risks through increased retention, water reuse, and urban greening.

Development programmes and spatial plans should set measurable targets for stormwater retention and green infrastructure, limit impervious surfaces, and require on-site water management. Parks, green corridors, and open spaces should be recognized as functional elements of blue-green infrastructure that provide flood buffering, cooling, and stormwater storage alongside recreational benefits.

8 Areas of the Kurzeme Planning Region Affected by Short-Term Flooding Caused by Heavy Rainfall

This section compiles information on areas within the Kurzeme Planning Region that are exposed to short-term flooding risks during periods of intense rainfall. The analysis is based on publicly available data, municipal studies, and open-access datasets. Particular attention is given to historical city centres with combined sewer systems and areas with partially degraded drainage networks, including sections located on private land.

At the end of the section, the inundated areas are categorised and potential solutions for flood-risk reduction are formulated, including both conventional and sustainable stormwater management approaches, such as rainwater reuse.

8.1 Identified Flood-Prone Areas in Municipalities

In the absence of detailed site-specific studies, flood-prone areas were mapped in the largest settlements of each municipality using a digital surface model with a spatial resolution of 20 m. Local topographic depressions were identified, which largely coincide with areas susceptible to flooding during intense rainfall events. These preliminary results were refined in consultation with municipal specialists, who highlighted particularly problematic locations.

8.2 Catagorization of Flood-prone Areas

Flood-prone areas in the Kurzeme region can be grouped into three main categories: combined sewer system areas, stormwater sewer areas with insufficient capacity, and areas with absent or degraded drainage systems. In historic city centres with combined sewers, intense rainfall frequently causes system overloads and polluted overflows due to the mixing of stormwater and wastewater. In newer stormwater sewer areas, 20th-century infrastructure is often unable to handle increasing rainfall intensities associated with climate change. In rural or peri-urban areas, flooding commonly results from non-functioning drainage systems that have been damaged or removed, often due to land ownership changes.

Across all categories, sustainable stormwater management measures, such as rain gardens, bioswales, permeable surfaces, green roofs, retention basins, and ponds, can reduce runoff, enhance local water retention, and mitigate flood risk. Where feasible, separating stormwater from wastewater systems and restoring drainage infrastructure can further improve resilience, although legal and property constraints may limit implementation in some areas.

9 Examples of Rainwater Reuse

This chapter presents various examples of rainwater reuse in Latvia and across Europe, ranging from municipal initiatives in Saldus to innovative projects in Poland, Sweden, Denmark, and Lithuania. These examples demonstrate how nature-based and technologically advanced approaches – such as rain gardens, green roofs, pond systems, and open drainage structures – can simultaneously reduce flood risks, conserve water resources, and enhance urban quality, thereby promoting climate resilience, ecological balance, and sustainable development.

9.1 Example of Rainwater Reuse in Saldus Municipality

A feasibility study in Saldus, Latvia, assessed the collection and treatment of surface runoff for municipal reuse, including irrigation of public green spaces and operation of a public fountain. The system involves rainwater storage in an underground tank, treatment by UV disinfection, and compliance with EU water quality classes A/B (Regulation 2020/741). Treated water is used for fountain operation and landscape irrigation, with excess discharge directed to the sewer system under municipal responsibility.

Within the WaterMan project, a construction design for the redevelopment of Kalpaks Square was developed in March 2024 by SIA “Livland Group.” The system includes rainwater collection, filtration through quartz filters, UV treatment, and sampling points for water quality monitoring. Backwash wastewater from the filters is discharged into the municipal sewer network. Public awareness activities on climate change and water scarcity accompanied the technical measures.

Saldus’ topography forms a natural depression, making the city center vulnerable to flooding during intense rainfall, while climate change also increases drought risk. The fountain was therefore designed as part of an integrated water management concept, combining flood mitigation, rainwater harvesting, and non-potable water reuse for irrigation, street cleaning, and fountain operation. The project enhances both urban resilience and public space quality.

The estimated implementation cost is EUR 618,383 (including 5% contingency and 21% VAT). Despite initial financial constraints, the project was finalized as a technically robust feasibility study with potential for phased implementation and replication in other Baltic Sea region municipalities. The Saldus case demonstrates how local urban initiatives can contribute strategically to climate resilience through integrated water management.

9.2 Examples of Rainwater Reuse Elsewhere in Latvia

The Skanste Green-Blue Corridor in Riga is one of the city’s major sustainable infrastructure projects. It provides stormwater retention, filtration through vegetation and soil, groundwater recharge, biodiversity conservation, and recreational value. The system reduces flood risks even under extreme rainfall scenarios and has demonstrated high economic efficiency, with a benefit-cost ratio exceeding 3.5:1.

Residential developments by Bonava Latvija in Riga illustrate sustainable rainwater management in the private sector. Projects on Turaidas Street and in the “Krasta Quarter” employ bioswales, infiltration trenches, and reservoirs that reduce runoff and improve the microclimate. These solutions proved effective during the 2024 storm, when flooding was minimal. The developer, in cooperation with researchers, continues to monitor system performance to improve technologies and reduce operational costs.

The Dailes Theatre Square Rain Garden in central Riga integrates stormwater infiltration into a public space. The landscaped depression improves runoff management, biodiversity, and the local microclimate while creating an aesthetically appealing environment.

The Rūjiena Cultural Centre Square demonstrates a comprehensive approach, combining rain gardens, bioswales, and a designed "dry riverbed", to ensure water filtration, infiltration, and microclimate regulation, while enhancing public space quality and aesthetics.

The Kandava Promenade features a cascade of ponds and ditches for stormwater conveyance and drainage within a playground area, ensuring a safe recreational environment and efficient urban water circulation.

The Elemental Business Centre in Riga reuses rainwater for irrigation and technical purposes, achieving the highest sustainability rating: BREEAM Outstanding. The solution reduces potable water consumption and maintenance costs while promoting responsible resource use among businesses.

9.3 Examples of Rainwater Use in Other WaterMan Project Model Regions

This section examines pilot projects in other WaterMan project model regions – Poland, Sweden, and Lithuania – which demonstrate various municipal-level solutions for rainwater storage, treatment and reuse. They show that locally adapted, nature-based approaches can be effective both for improving the urban environment and for conserving resources.

In Poland, two pilot projects have been implemented in **Braniewo Municipality**. A rain garden was established in the parking area of a public swimming pool to manage stormwater locally. Formerly sealed surfaces were replaced with vegetated depressions and a retention pond that collect runoff from streets and the pool roof. The system relies on natural purification processes – sedimentation, filtration, sorption, and biodegradation – enhanced through eco-engineering design. Collected rainwater is reused for irrigating surrounding vegetation, while infiltration and evapotranspiration reduce pressure on the municipal sewer network.

The project improves urban microclimate, mitigates flood risk in the Pasłęka River basin, and reduces the urban heat island effect. Implemented without complex technology, it was developed through cooperation between the Braniewo municipality and Gdańsk University of Technology. The rain garden also serves as an educational site, informing visitors about climate change adaptation and nature-based water management solutions.

Braniewo Municipailty also implemented a pilot project to reuse wastewater generated from swimming pool filter backwashing, a process that typically discharges large volumes of potable water into the sewer system. The collected water undergoes natural dechlorination, coagulation-flocculation, and sedimentation, achieving EU Regulation 2020/741 A/B quality standards. Treated water is reused primarily for sewer flushing and potentially for irrigation, reducing potable water consumption by approximately 15%.

The system enables the reuse of up to 50% of backwash wastewater, lowering sewer discharge volumes by 40-50%. Although retrofitting existing infrastructure posed technical and regulatory challenges, the project demonstrates that integrating water reuse into new pool designs could significantly increase water recovery, including from showers. The initiative highlights the role of decentralized, circular water systems in climate-resilient urban water management.

In **Västervik, Sweden**, a system of multi-functional rainwater ponds was developed to collect surface runoff from an 80-hectare catchment area. These ponds serve both flood control and water supply functions, providing untreated rainwater for irrigating sports fields, urban green areas, cemetery landscaping, artificial snow production, and small-scale industrial washing. Natural purification occurs through sedimentation and wetland processes, achieving EU Regulation 2020/741 Class D water quality.

Following successful implementation in Gamleby in 2020, the municipality shifted toward a decentralized model with multiple small ponds located near end users. This approach reduces costs, improves water accessibility, and decreases reliance on drinking water during drought periods. The multi-pond concept demonstrates how stormwater can be transformed into a reliable local resource while supporting climate adaptation and biodiversity conservation.

In **Gargždai, Lithuania**, a rainwater retention pond was constructed to collect and naturally treat runoff from a 110-hectare residential catchment. The system uses two-stage sedimentation and biological degradation to remove pollutants without mechanical treatment. Initially designed for flood mitigation, the pond now supplies water for street cleaning, sewer flushing, firefighting, and irrigation of public green areas, reducing potable water use.

The project was implemented by Klaipėda District Municipality with scientific support from Klaipėda University and co-financed by the Interreg Baltic Sea Region Programme. It also served as a legal pilot, helping define national procedures for water reuse in line with EU Regulation 2020/741. Monitoring confirms stable chemical and microbiological water quality, demonstrating that nature-based solutions can provide cost-effective, climate-resilient alternatives for municipal water management.

9.4 Examples of Rainwater Use in Europe

This section analyses various rainwater management solutions in Sweden, Denmark and Poland. These examples illustrate nature-based, integrated and sustainable approaches to urban development that simultaneously ensure rainwater collection, treatment and reuse, thereby promoting climate resilience and ecological balance in cities.

9.4.1 Sweden

In Sweden, the city of Malmö has become a leading example of sustainable rainwater management.

Dagvattenparken (Stormwater Park) in the Hyllie district is a 23,000 m² green area that combines a recreational function with a water retention system. The park’s topography and ponds can accommodate up to 6,600 m³ of water during intense rainfall events, reducing flood risk while improving the landscape and biodiversity.

Hyllie Vattenpark is an educational and interactive park where residents, especially children, can learn about the principles of the water cycle and the impacts of climate processes. It serves as a platform for public information and environmental awareness-raising.

Hyllievångsparken, whose development began in 2018, has been designed as a dynamic and climate-resilient urban environment with rainwater retention depressions and a stream system capable of storing up to 7,000 m³ of water. The park combines recreation, ecological design and community engagement.

The Emporia shopping centre in Malmö is notable for its 27,000 m² green roof – one of the largest in Europe – which reduces the heat island effect, improves rainwater retention and promotes biodiversity.

Västra Hamnen (Western Harbour) has been transformed from an industrial zone into a carbon-neutral residential district. Rainwater is managed in an open system: it is retained on green roofs, in canals and ponds, creating an aesthetically attractive urban environment.

Ekostaden Augustenborg (Eco-City Augustenborg) is one of the most significant urban regeneration projects in Europe. Its open stormwater drainage system (6 km of channels and 10 ponds) can retain up to 90% of rainwater, fully preventing flooding. The project also includes green roofs, the use of renewable energy and extensive public participation, improving both ecological and social indicators.

9.4.2 Denmark

Biodiversitetspark (Biodiversity Park) in Greve Municipality is a complex of stormwater ponds that retain precipitation, thereby reducing flood risk and simultaneously improving water quality. The park is used to test a new filtration method (the SCL system), which enables water to be purified before further discharge, reducing operational costs and enhancing biodiversity. In addition to its technical functions, the park includes walking paths, small bridges and platforms, making it a recreational and educational environment.

9.4.3 Poland

The Sokołówka River restoration project in Łódź is a significant example of applying ecohydrological principles in urban planning. Within the project, three stormwater reservoirs and a biofiltration system have been constructed, which reduce flood risk, improve water quality and foster biodiversity. This initiative marks a shift towards an integrated “blue-green network” approach that delivers both ecological and social benefits, including public participation and increased urban attractiveness.

9.5 Good Practice and Typical Examples of Rainwater Reuse

Rainwater reuse systems are widely applied for non-potable purposes such as toilet flushing, garden and lawn irrigation, and, in some cases, for irrigating food crops under appropriate conditions. In residential buildings, rainwater is typically collected from roof surfaces, filtered to remove coarse debris, and stored in above-ground or underground tanks. The stored water can be supplied by gravity or pumps to toilets or irrigation systems, with automatic switching to the central water supply when tank levels are low. For irrigation of lawns, trees, and ornamental plants, only minimal treatment is required, usually consisting of debris screening, first-flush diversion, and sediment filtration, while disinfection is generally unnecessary if storage times are short and human exposure is limited.

Where soil and groundwater conditions permit, nature-based solutions such as rain gardens and bioswales can be used to treat and infiltrate stormwater. Excess water is directed to drainage or overflow wells with permeable bases, allowing infiltration into the subsoil. During dry periods, stored or infiltrated water can be abstracted for irrigation, providing a low-cost and environmentally sustainable solution. In areas with sufficient space, ponds can serve as multifunctional storage systems that support irrigation, enhance landscape quality, promote biodiversity, and contribute to stormwater retention.

In commercial and public buildings, larger-scale systems are commonly implemented. Rainwater is collected from extensive roof areas and stored in underground tanks with capacities of 10,000-50,000 litres. Treatment typically includes first-flush diversion, filtration, and, where required by regulations, disinfection using UV or activated carbon systems. Automated pumping and control systems ensure reliable supply, while a separate non-potable water network distributes rainwater exclusively to toilets. These systems reduce potable water demand, lower sewerage loads, and improve the overall sustainability of urban water management.

Rainwater reuse for non-potable purposes provides clear environmental benefits by reducing potable water demand and sewerage loads. While financial returns may be limited under current tariff structures, higher water prices, larger collection areas, and lower installation costs can significantly improve economic feasibility.

9.6 Economic Effectiveness of Rainwater Reuse

International practice demonstrates that the economic performance of rainwater and greywater reuse is highly context-dependent and is primarily shaped by water and sewerage tariffs, system scale, regulatory requirements, and whether solutions are integrated at the design stage. In **Nye (near Aarhus, Denmark)**, the utility Aarhus Vand has implemented a centralized system that collects rainwater and surface runoff from roofs, streets, and a lake, treats it via pressure filtration and ultrafiltration (approximately 0.02 µm), applies UV disinfection, and distributes the resulting secondary water through a dedicated network for toilet flushing and laundry. The system is designed to supply up to 40% of total demand, initially serving about 600 households with long-term expansion to roughly 15,000 residents. From the end-user perspective, costs are largely embedded in the housing connection arrangement rather than borne as individual household investments, while the high Danish water price level increases the value of avoided potable groundwater use; reported connection fees are on the order of EUR 3,600 per household, with operating costs typically managed centrally.

A building-scale example is the **Ibis Gent-Dampoort hotel in Belgium**, which reuses treated shower water for toilet flushing and employs a smart buffer tank to manage peak demand. The system reportedly saves about 1,500 m³ of potable water annually per building and has a published payback period of approximately 7-8 years under local tariff conditions, indicating that greywater reuse can be economically viable in high-occupancy facilities with stable demand profiles.

In **Sörsjön (Jönköping region, Sweden)**, a multi-apartment development integrates greywater reuse and rainwater harvesting to reduce potable water consumption by about 30%. While reported operating costs per apartment are relatively low, indicative payback periods can be long when assessed solely against potable water savings; however, Swedish pilot experience suggests that viability improves when sewerage charges, economies of scale, and subsidies are included in the appraisal.

At the household scale, the Dutch **“Circular Water Home” pilot in Boskoop** combines rainwater harvesting (treated for use in showers, baths, sinks, and irrigation) with greywater recycling using a Hydraloop unit for toilet flushing and laundry. Reported performance includes potable water savings exceeding 90% and a reduction in wastewater volumes of around 40%, but payback varies widely: low-cost self-built configurations can approach a decade, whereas modular commercial systems often require multiple decades unless supported by higher tariffs or incentive schemes.

A representative **United Kingdom cost guide** similarly indicates substantial variability, with typical greywater system installation costs ranging from approximately EUR 1,700 to 5,700 and low annual operating costs, implying payback periods that may range from roughly one to several decades depending on installation complexity, achievable water savings, and whether the system is integrated into new construction or retrofitted.

Overall, the reviewed cases suggest that centralized or high-demand building applications tend to deliver more favourable economics than small, fully "active" household systems, while policy incentives, inclusion of avoided sewerage costs, and early-stage integration into building design can materially improve financial performance.

10 Potential Funding Sources and Financial Benefits for Addressing Rainwater and Treated Wastewater Management Issues in Municipalities

This section summarises the main financial instruments and programmes that provide support to municipalities for the implementation of sustainable rainwater and wastewater management projects, highlighting the importance of cross-border cooperation, innovation and research for the development of climate-resilient infrastructure.

The section further outlines the key financial benefits of integrated stormwater management and water reuse for municipalities, including reduced infrastructure, maintenance, and flood-damage costs. It highlights how lowering potable water use for irrigation and decreasing stormwater inflow into sewer systems can generate significant long-term economic savings for both utilities and society.

10.1 Funding Sources

In Latvia and the European Union, several financial instruments are available that promote sustainable water resource management, infrastructure development and climate adaptation measures. **The Latvian Environmental Protection Fund** provides funding for projects aimed at improving environmental quality, including the introduction of rainwater management solutions and public education. **EU Structural Funds** (ERDF, CF, ESF+) offer substantial support for large-scale infrastructure and technological modernisation projects, including the construction of centralised sewerage and rainwater collection systems and the deployment of climate-resilient solutions.

Interreg programmes (Latvia-Estonia, Latvia-Lithuania, Baltic Sea Region, and Central Baltic) foster cross-border cooperation in the fields of water resource management, biodiversity and urban sustainability, providing co-financing of up to 80% of eligible costs. Municipalities, research institutions, enterprises and non-governmental organisations may participate in these programmes.

In addition, the **Horizon Europe programme** supports research and innovation projects in water management, rainwater reuse and climate risk reduction, while the **European Bauhaus Initiative** funds urban development projects that combine sustainability, aesthetics and public participation, including nature-based rainwater management solutions.

10.2 Financial Benefits for Municipalities

Municipal investments in integrated stormwater management and the reuse of treated wastewater generate both direct cost savings and long-term economic benefits. By implementing nature-based and decentralised solutions, such as rain gardens, open drainage systems, retention basins, and floodplains, municipalities can reduce reliance on expensive, pipe-based flood protection and sewer system upgrades. These measures help attenuate peak flows, lower maintenance needs, and reduce the frequency of system overloads, pump operation, and emergency repairs. In addition, reduced flood damage leads to lower expenditures for infrastructure repairs, compensation, and emergency response.

The reuse of rainwater and treated wastewater for non-potable purposes, including street cleaning, irrigation of green spaces, and technical uses, decreases demand for potable water abstraction and treatment. It also reduces the volume of stormwater entering wastewater treatment plants, lowering operational costs and energy consumption across water supply and sewerage systems. Over the long term, these effects can contribute to more stable utility tariffs and reduce the need for major tariff increases, particularly as climate and cohesion funding instruments increasingly support integrated stormwater and nature-based solutions.

A key direct benefit arises from replacing potable water used for irrigation. Although detailed local data are limited, seasonal consumption patterns in the Kurzeme region indicate that irrigation accounts for approximately 3-5% of annual water use. Based on conservative assumptions, the annual cost of potable water used for irrigation in the region is estimated at around EUR 625,000. While this represents only a small share of total utility revenues and therefore does not significantly reduce system-wide costs, households, institutions, and businesses that switch to alternative water sources can achieve tangible financial savings.

An even larger economic benefit is associated with reducing stormwater inflows into combined sewer systems. In the Kurzeme region, stormwater and infiltrated groundwater can account for up to half of the total wastewater volume treated. The annual cost of managing this additional flow exceeds EUR 5 million. As much of this water originates from public streets or unidentified sources, the associated costs are effectively borne by all users through tariffs or municipal subsidies. Consequently, measures that reduce stormwater inflow into sewer systems, such as infiltration, retention, and reuse, offer significant financial advantages for society as a whole and should be considered in economic evaluations of stormwater management strategies.

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eurobalt.org/WaterRecyclingToolbox
interreg-baltic.eu/project/waterman

WaterMan promotes a Baltic Sea Region-specific approach to water recycling, which makes use of the alternation of too much and too little water that has become typical for humid areas in the EU to strengthen the resilience of local water supply. Building on this approach, the project supports municipalities and water companies in adapting their water supply strategies.

The contents of „BSR Water Recycling Toolbox" are the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union, the Managing Authority or the Joint Secretariat of the Interreg Baltic Sea Region Programme.

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