From Theory to Practice: Enhancing Water Resilience Through the Soolikaoja Floating Islands and Other Nature-Based Solutions in Estonia

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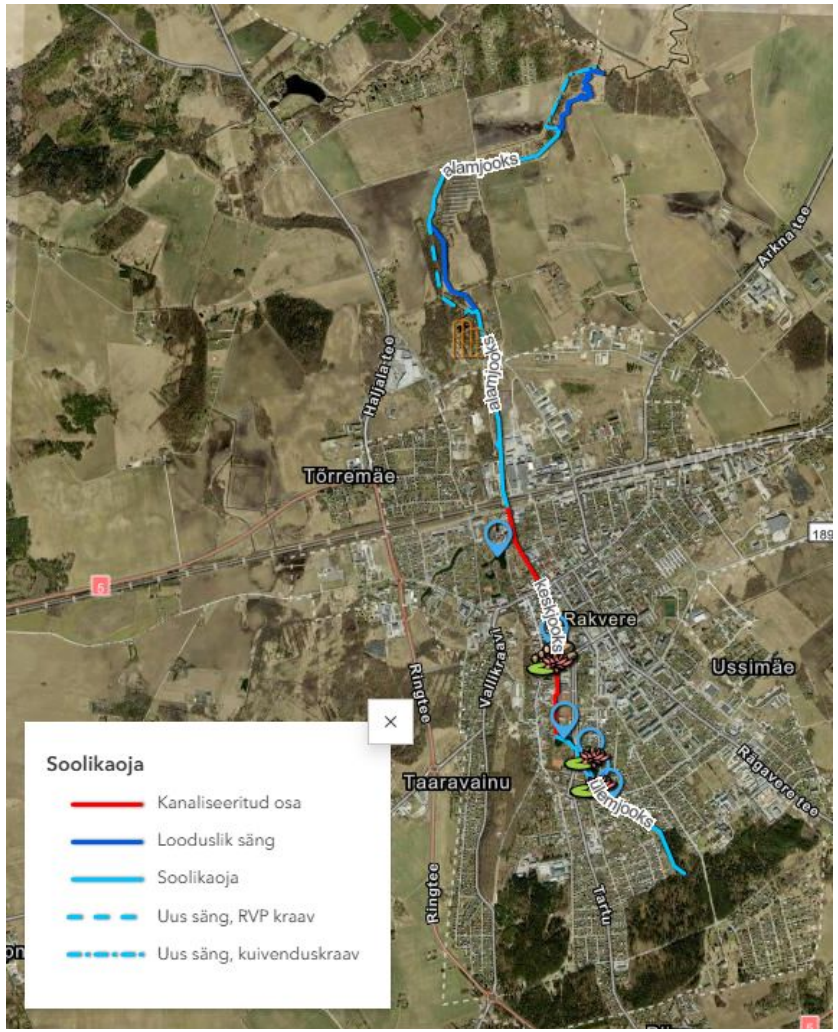
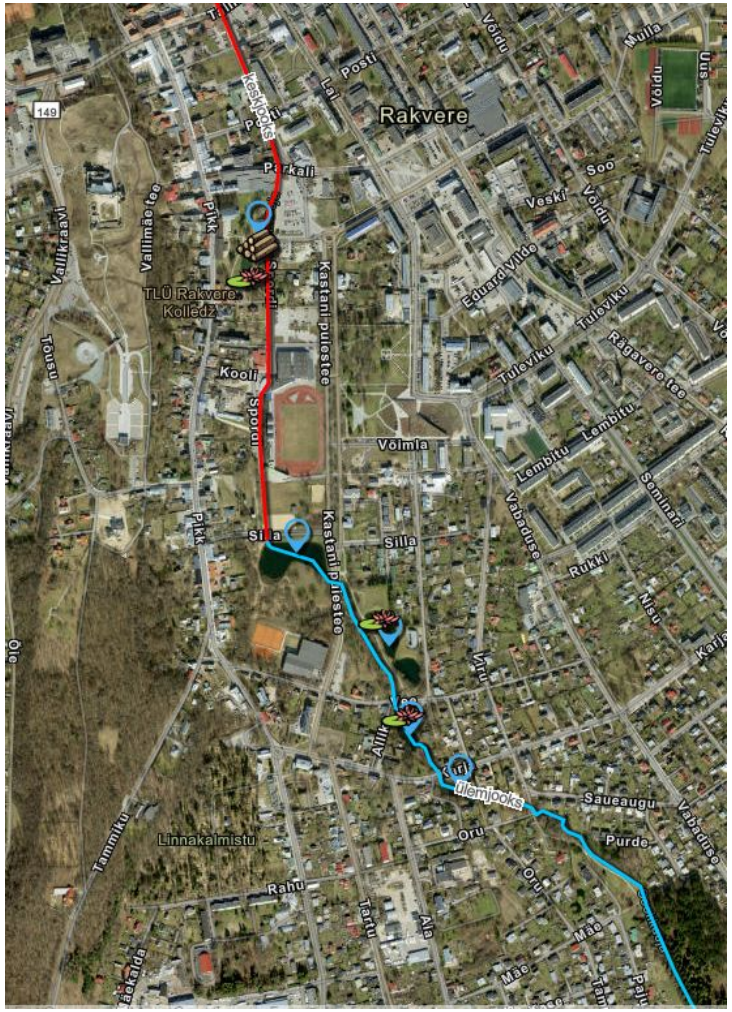
Building Water Resilience: The Case for Nature-Based Solutions in Estonia

- Water resilience: The capacity of water systems to adapt to and recover from climate and pollution stressors
- **Traditional "gray" infrastructure proves inadequate against modern water challenges in Estonia**
- **Climate instability and nutrient pollution require adaptive approaches that respond to local conditions**
- **The Soolikaoja floating islands demonstrate effective integration of natural processes with infrastructure**
- Nature-Based Solutions (NBS) create systems that simultaneously:
  - Enhance water quality through natural filtration
  - Build resilience against extreme weather events
  - Deliver multiple ecological and community benefits
  - Provide cost-effective alternatives to traditional infrastructure

Case Study: Soolikaoja

- Project: **LIFE IP CleanEST**
- **7,5 km long creek,**
- catchment area **122 km^2**
- locates in Rakvere City
- heavily **modified** waterbody
- ecological status: **bad**
- Measures:
    1. **floating islands**
    2. **in-stream wood chip bioreactor**





Floating Islands

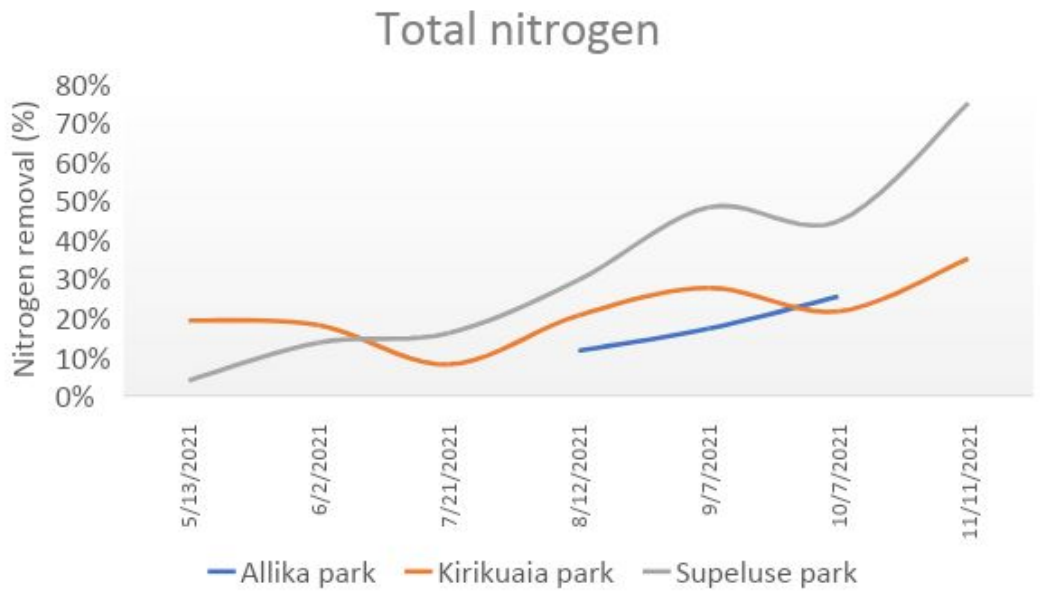
- Miniature ecosystems that enhance water purification
- Plant roots provide surfaces for beneficial microorganisms
- Natural absorption of excess nutrients
- Stabilize the body of water against sudden increases in pollutants during heavy frain
- Additional benefits: habitat creation, aesthetic improvement

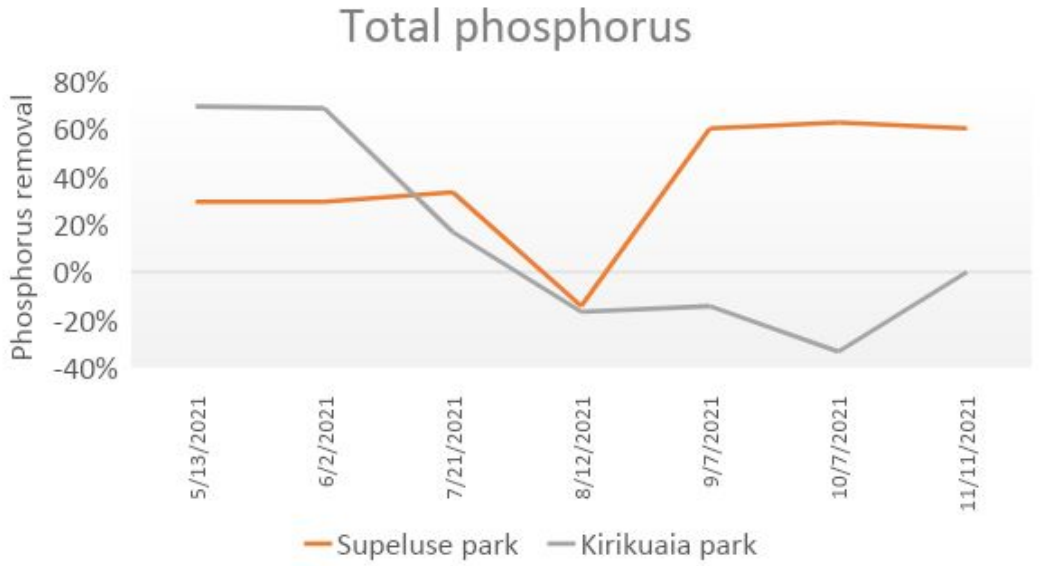
- **Floating islands were installed 2021:**
- **11 islands**
- **total area 172,4 m^2 (**Kirikuaia (3; 18 m^2), Supeluse (5; 96,5 m^2), Allika (3; 57,9 m^2))
- The frame of the floating islands was built from 200 mm PEM pipes.
- A commercially available 14mm metal mesh was used as the bottom, which was attached to the edge formed by pipes.
- Coconut mat and rock wool were placed on the mesh to secure the plants and create a growing medium.
- The following plants were planted on the floating islands:
  - *Eriophorum angustifolium*
  - *Typha gracilis*
  - *Typha minima*
  - *Iris pseudacorus* 'Variegata'
  - *Juncus effusus* 'Spiralis
  - *Pontederia cordata* 'White Spike'
  - *Iris sibirica* 'Blue King'
  - *Iris sibirica* 'Weisser Orient'

The plants were planted in rock wool so that the root system reached into the water.

Effectiveness of Floating Islands

- **Water was analysed before** installing the islands and **after** that **monthly** till end of 2022: BOD_5, COD, TSS, PO_4-P, P_{tot}, NH_4-N, NO_3-N, NO_2-N, N_{tot}
- Floating islands were somewhat **successful in nitrogen removal**
  - In Supeluse park, where the lake has greatest retention time up to 70% of nitrogen could be removed
- **No major decreases** were observed **in phosphorus and suspended solids**, and the increase is largely related to summer algae blooms.





- Significant part of the nutrient load is likely to come from Soolikaoja catchment area. The creek flows through the city of Rakvere and collects water from **several wastewater treatment plants** and **stormwater discharges**.
- **Soolikaoja is mainly fed by groundwater** and therefore affected by **the high nitrate content of groundwater,** to which is added an additional **phosphorus load from the effluent outlet of the Rakvere municipal wastewater treatment plant** downstream.
- The **dam lakes** upstream of the creek **are heavily eutrophic**, which in turn has a **negative impact on aquatic life**.

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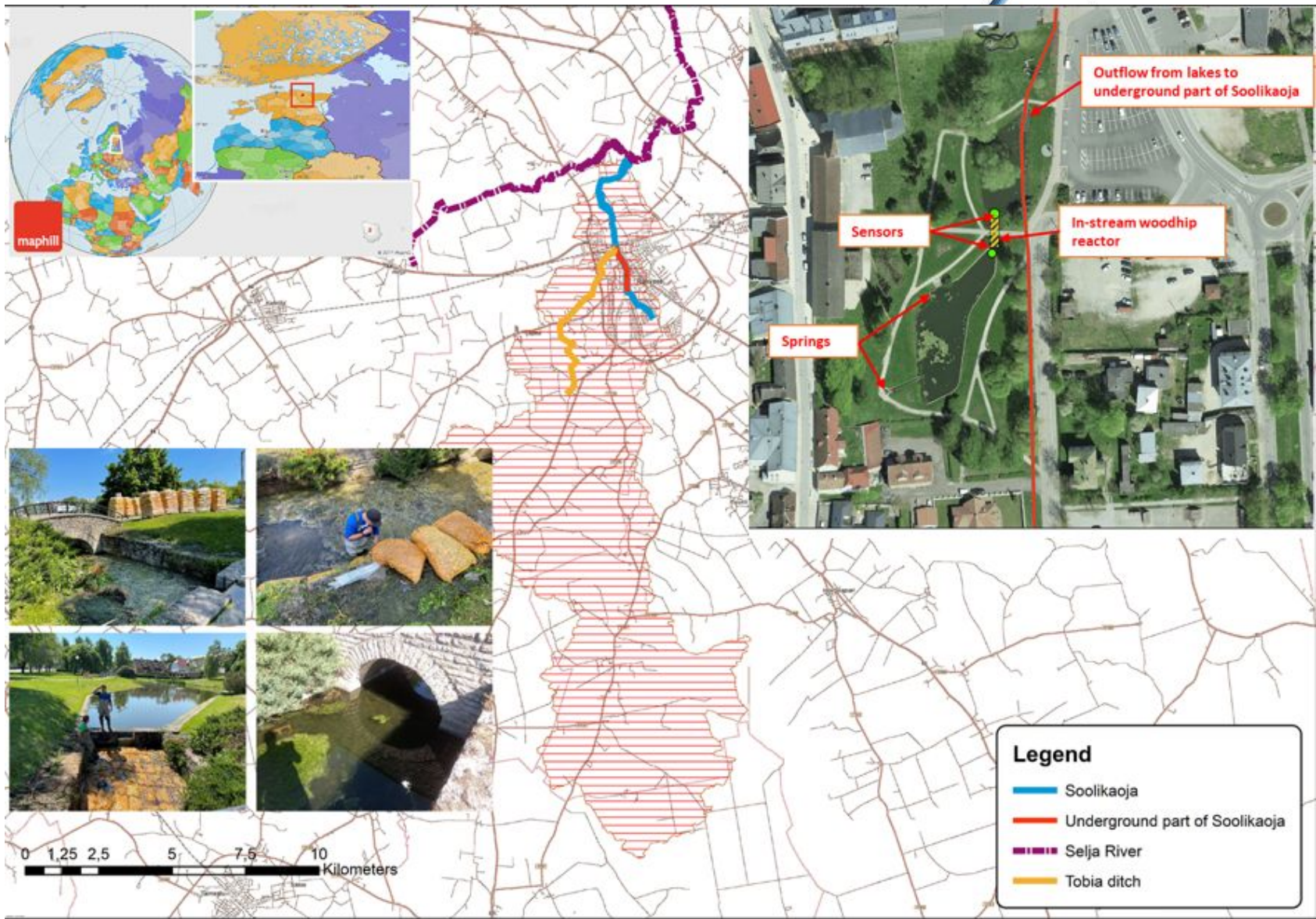
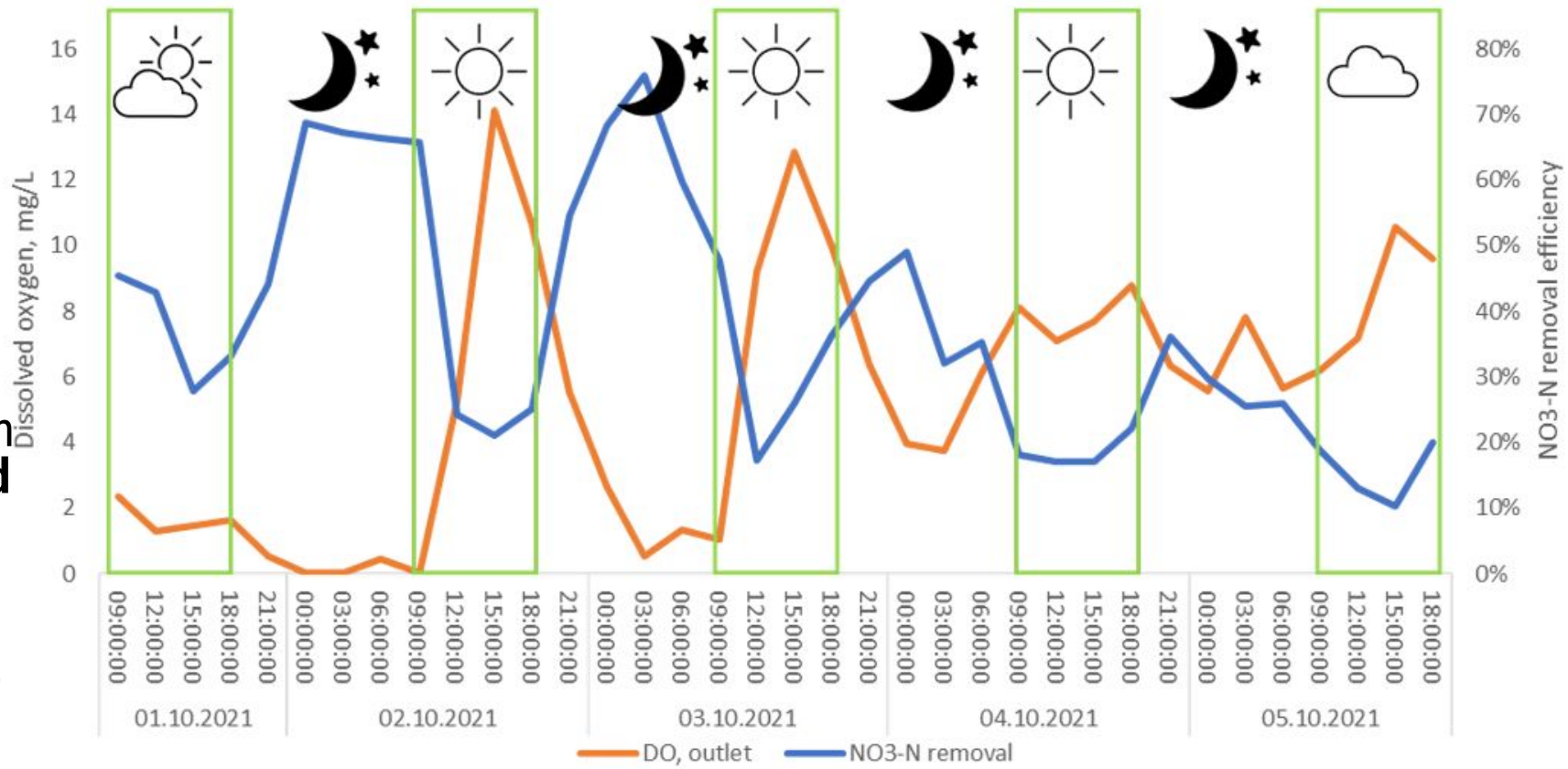
In-stream woodchip bioreactor

- In order **to reduce nitrate concentrations** in the surface water **a pilot scale in-stream woodchip reactor** was installed in June 2021.
- **7,5 m^3 of wood chips packed in 40-liter bags** were installed **at the bottom of the canal (14 x 3 m)** between two ponds.
- Bags were placed on existing sediment layer.
- Entire bottom of the channel was evenly covered by bags.
- Reinforcing nets were placed on top of the bags to secure and immerse the wood chips.
- **Hydraulic retention time** of the system (channel and bioreactor) **was between 5,0 and 7,5 hours.**



- Preliminary results show that an **average NO_3-N removal rate was 43,7 gN $m^{-3}d^{-1}$,** but it varies between 9,5 and 99,3 gN m^{-3} d^{-1}.
- **An average nitrate removal efficiency was 43,6 ± 18,8 %.**
- The performance of the in-stream denitrifying woodchip bioreactor **was strongly dependent on the dissolved oxygen concentration** in the eutrophic water and its **limited by photosynthesis and eutrophication.**
- So in stream this **solutoion poses risk of anoxia**, **more suitable near river**.



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LIFE UrbanStorm project (2018-2023)

- Aimed to develop sustainable and climate-resilient urban stormwater systems with goal to reduce the vulnerability of Estonian cities to the effects of climate change and increase the capacity of cities to mitigate floods caused by torrential rains.
  - Project was testing solutions in Viimsi Municipality **Viimsi manor park** and **Randvere street parking lot**.
  - Viimsi manor park 225 m ditch was renovated, whole design covered 4600 m^2 with aim to decrease flow rate, support the water retention, protect ditch banks from erosion.
  - Randvere street parking lot (3425 m^2, 64 parking spots) was reconstructed to prevent floods and rainwater reaching to sewage system, manages 60 min heavy rain.

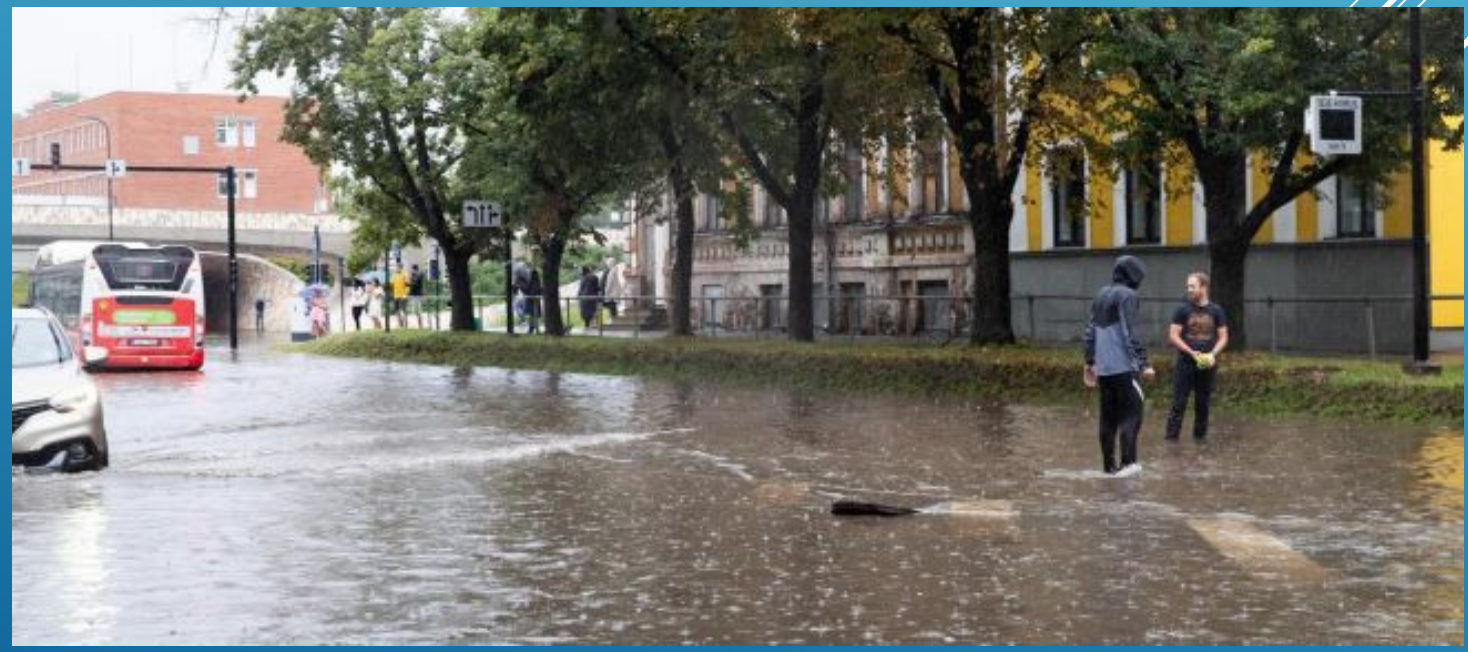
LIFE LATESTadapt (2022-2027)

- Developing and demonstrating portfolio of nature based and smart solutions for **improving urban climate resilience** in Estonia and Latvia

Activities:

- Using the **native plant communities** at NBSs for urban flood resilience
- **Novel solutions** for **pluvial flood mitigation** combining NBS & smart technologies
- Identifying and testing **novel sensing techniques** to monitor NBS performance

- 8 demonstration sites
  (5 in Estonia and 3 in Latvia)



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Central Baltic Programme

Interreg MUSTBE project (2023-2026)

Multidimensional storm water treatment in urban areas for cleaner Baltic Sea

- Aims at improving the condition of the Baltic Sea by treating stormwater that reaches the sea by developing **novel multi-benefit stormwater management systems**.
- Aim to **combine nature-based stormwater solutions** with **digital solutions** to maximize stormwater treatment efficacy and municipalities capacity to monitor the actual **quality of the stormwater**.
- In total 7 pilot sites will be set up in 4 countries (Estonia, Latvia, Finland, Sweden).
- Cross-border co-operation will ensure the necessary technological innovation that is in focus within visioned stormwater solutions and ensure replication of the technological innovation on international level.

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LIFE Mires Estonia project (2015-2021)

Conservation and Restoration of Mire Habitats

- Bogs purify and store water
- Bogs regulate the water regime in the landscape and thus alleviate droughts and floods
- **Mires cover 5,2% Estonia** (*ca* 240 000 ha), **total area of mires in Estonia has decreased about 25–3 times** during the last century
- **Project helped to recreate conditions that allow for the restoration of a typical water regime across 7,900 hectares** of mires: Tudu (2089 ha), Ohepalu (1120 ha) and Sirtsi (2779 ha), Soosaare (167 ha), Laukasoo (1149 ha), and Feodorisoo (597 ha)
- Main technical measures were: **cutting trees, closing ditches by damming or filling and redirecting water flow, in case of remediation of abandoned peat mining areas also including reintroduction of peat moss**

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cleanest

Thank you!

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