

ADAPTING WASTEWATER MANAGEMENT TO SEASONAL TOURISM PEAKS IN THE BALTIC SEA REGION

THE PROBLEM

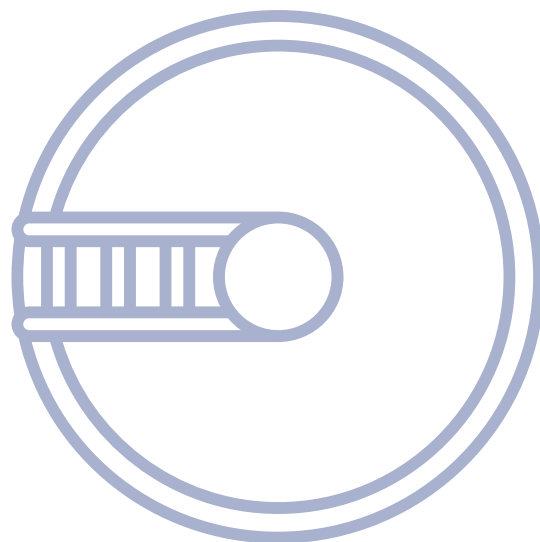
Seasonal tourism in rural Baltic Sea areas causes large wastewater load fluctuations. Small wastewater treatment plants (WWTPs) (<2,000 PE) often lack capacity and fall outside strict regulations, leading to nutrient discharge and eutrophication.

WHY IT MATTERS

- Threatens marine ecosystems and biodiversity.
- Undermines tourism-based economies.
- Cumulative impact of small WWTPs is significant.
- Harms the local environment, e.g. bathing water quality, and poses health risks.

KEY SOLUTIONS TESTED

- Aeration upgrades (nanobubbles) to boost capacity.
- Compact bioreactors for stable performance year-round.
- Constructed wetlands (aerated/hybrid) for polishing effluent.



STRENGTHENING SMALL WWTPS UNDER SEASONAL PRESSURE - FOUR PRIORITY POLICY ACTIONS

1. Strengthen oversight of small WWTPs with seasonal wastewater fluctuations

Intensify monitoring, harmonise data collection at national and EU level, and establish a national database capturing performance and seasonal load data.

2. Promote seasonally adaptive wastewater treatment technologies

Support technologies that enable process intensification during peak seasons and stable, efficient operation during low-load periods.

3. Prioritise operationally simple wastewater treatment solutions

Promote low-maintenance solutions, especially in tourist areas and rural contexts, supported by simple operational guidance.

4. Integrate simplified life-cycle-based criteria into green public procurement

Embed streamlined Life Cycle Assessment screening in procurement and technology selection for small-scale wastewater treatment projects.

ADAPTING LOCAL WASTEWATER MANAGEMENT TO SEASONAL CHALLENGES



Pilot activities in rural areas at Baltic Sea Region tourist destinations
Recommendations from the EU Interreg Project NURSECOAST-II.



THE CHALLENGE

Nutrient pollution in the Baltic Sea is a growing concern, exacerbated by population growth and increasing tourism. More visitors lead to higher wastewater volumes, and if not properly treated, excess nitrogen and phosphorus enter the sea, causing eutrophication, oxygen depletion, and harm to marine ecosystems. This threatens not only biodiversity but also the tourism industry, which relies on clean waters and healthy coastal environments.

Addressing these issues requires practical, scalable solutions that can be adopted without incurring high costs or technical burdens. This need is reinforced by the 2025 revised EU Urban Wastewater Treatment Directive (UWWTD), that expands regulatory coverage from 1,000 PE (population equivalent), with treatment requirements applying from 2035. Although plants below 1,000 PE remain outside its direct obligations, their cumulative impact is considerable, particularly in tourist destinations. Therefore, there are immediate challenges in managing seasonal wastewater loads as well as longer-term responsibilities to prepare for compliance.

THE APPROACH

A variety of technological and nature-based methods are available to enhance wastewater treatment and explore alternative uses for treated water, such as irrigation. Practical insights show how these solutions can increase treatment capacity, maintain stability under seasonal fluctuations, and support more sustainable management in tourism-focused coastal areas. This document builds on these lessons to offer recommendations, including integrated Water Service Plans for municipalities. Additionally, the document emphasises the importance of these measures within international and European policy frameworks and sustainability objectives.

► *This document has been developed within the framework of the Interreg Baltic Sea Region project, NURSECOAST-II (2023-2026). It is designed for national and county-level policymakers, as well as local authorities responsible for investment decisions in wastewater infrastructure. Its goal is to support local decision-making to implement effective wastewater treatment solutions in rural tourist destinations.*

ADAPTING LOCAL WASTEWATER MANAGEMENT TO SEASONAL CHALLENGES

THE PILOTS

Technological and nature-based wastewater treatment approaches have been tested. The case sites illustrate the diverse challenges faced by municipalities in tourism-intensive coastal regions and demonstrate practical pathways to improve system resilience.

NÆSTVED, DENMARK



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- ▶ 645
- ▶ Nutrient discharge, greenhouse gas emissions
- 🔄 Full aeration with nanobubbles has been tested at pilot scale

BARÖSUND, FINLAND



©Vestelli

- ▶ 20
- ▶ Marina, 100-200 tourists daily during high season, exceeds the capacity of the WWTP
- ▶ Nutrient discharge, odour
- 🔄 Scaling and updating on-site WWTPs: sludge-recirculating, continuously operating bioreactor

SKOVGAARD GODS, DENMARK



©Nina Effelsberg

- ▶ No permanent residents
- ▶ UNESCO Global Geopark, 60 x more wastewater in summer
- ▶ No local treatment of wastewater, wastewater composition deviated from typical wastewater
- 🔄 Intensified constructed Wetland with Aeration

BLĀZMA, LATVIA



©Nina Effelsberg

- ▶ 332
- ▶ Nutrient discharge, land use, odour
- 🔄 Constructed wetland as a post-treatment solution

JURKALNE, LATVIA



©Johanna Lehtmees, S&P Tallinn

- ▶ 206
- ▶ One of the most visited tourist destinations in Latvia
- ▶ Nutrient discharge, odour, land use
- 🔄 Nanobubbles have been used to enhance aeration and pollutant degradation in an existing treatment plant

NOWY KLINCZ, POLAND

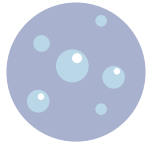


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- ▶ 58
- ▶ 160 people during the summer
- ▶ Nutrient discharge, land use, odour
- 🔄 Constructed wetland, nanobubbles and reuse of treated wastewater for irrigation

- ▶ Population
- ▶ Characteristics
- ▶ Challenges
- 🔄 Approach

KEY FINDINGS



Nanobubble Aeration

The use of nanobubble technology in aeration can improve the capacity of biological treatment plants and enhance the treatment efficiency of high seasonal nutrient loads. Improved ammonium conversion, COD reduction and overall process stability was observed, especially during peak tourist seasons. The nanobubble generator is an external unit, which simplifies its implementation. It has the potential to support capacity as a complementary solution; performance depends on process characteristics and sizing.



Sludge-Recirculating Bioreactors

The renewal of a wastewater treatment system to one with greater capacity can be necessary when its capacity no longer meets the actual load, and operational improvements are insufficient to ensure the required purification efficiency. This is especially critical in areas with strong seasonal variation. In such cases, sludge-recirculating, continuously operating bioreactors provide a technically robust solution for both off-season and peak-season conditions with fluctuating inflow volumes. They maintain high purification efficiency and stable performance even under variable environmental and loading conditions.



Constructed Wetlands (Hybrid/Aerated)

Constructed wetlands remain a cornerstone of nature-based wastewater treatment, but their performance can be improved through proper design and aeration, particularly in areas with high seasonal variability in wastewater volume. Aerated wetlands reduce ammonia and help handle high wastewater loads during the tourist season. To save energy, aeration should be stopped during low season periods. Additionally, recirculating nanobubble-enriched water into constructed wetlands has shown potential for further enhancing nutrient removal and overall treatment performance.

Hybrid wetland systems, combining vertical and horizontal flow, are recommended for high-load wastewater. Remote monitoring increases operational reliability, even in small-scale setups. For small tourist destinations it is also simple to operate, it is important though to have well-defined operational protocols.



Municipal Planning Tools

Legislative measures can play a key role in promoting the adoption and use of new innovative wastewater treatment technologies or nature-based and circular solutions by creating incentives and financing opportunities. This can help overcome barriers to adoption, encourage innovation and ultimately lead to more sustainable wastewater treatment practices. Also there is a need for a national database for small wastewater treatment plants under 2,000 PE to ensure that these plants are operating efficiently and in compliance with environmental regulations.

RECOMMENDATIONS

1 Strengthening the management of small WWTPs with seasonal wastewater fluctuations

Short-term

The revised EU Urban Wastewater Treatment Directive (UWWTD), effective from 1 January 2025, extends regulatory coverage to agglomerations above 1,000 population equivalents (PE), with treatment obligations entering into force in 2035. However, WWTPs below 1,000 PE remain outside the directive's direct scope, despite their potentially significant cumulative environmental impacts. This gap is particularly relevant in areas affected by seasonal tourism, where short-term population peaks can significantly strain treatment capacity and performance.

Monitoring of treatment performance and influent loads in small WWTPs should be intensified, with harmonised data collection practices at national and EU level. National authorities, in cooperation with municipalities and operators, should establish a regularly updated national database including plant location, capacity, operational performance, and nutrient loads. Explicit consideration of seasonal tourism, including short-term visitors, would improve forecasting and risk-based prioritisation of investments.

Long-term

In the long term, harmonised and transparent datasets should support strategic planning, resource allocation, and preparedness for future regulatory developments. Strengthening the evidence base will help ensure stable operation and environmental compliance of small WWTPs under increasing seasonal and climate pressures.

2 Promote seasonally adaptive wastewater treatment technologies

Short-term

Seasonal load variability requires treatment technologies that can be intensified during peak periods and efficiently downscaled during low-load seasons. In the short term, municipalities and WWTP operators, together with technology providers, should deploy seasonally adaptive solutions such as enhanced aeration (e.g. nanobubble technologies) and flexible process control. These solutions can increase the effective capacity of existing infrastructure without full system replacement.

Long-term

In the long term, modular and scalable treatment systems should be prioritised in planning and upgrading decisions. Adaptable infrastructure increases resilience, cost-effectiveness, and long-term compliance under fluctuating demand patterns.



RECOMMENDATIONS

3 Prioritise operationally simple treatment solutions

Short-term

Operational complexity remains a key barrier for small WWTPs. Constructed wetlands and other nature-based solutions, including intensified or intermittently aerated systems, offer low-maintenance and cost-effective treatment options, particularly in rural or tourist areas. These systems are well suited to seasonal nitrogen removal and nutrient retention. To support implementation, simple, user-friendly operational manuals should be developed for small-scale operators.

Long-term

Policy makers and environmental authorities should embed nature-based wastewater treatment solutions within broader green and circular infrastructure strategies, delivering co-benefits for biodiversity, climate adaptation and resource efficiency.

4 Integrate simplified life-cycle-based criteria into green procurement

Short-term

Policy makers and permitting authorities should integrate simplified Life Cycle Assessment (LCA) screening into green public procurement and technology selection processes for small WWTP projects. Priority impact categories should include energy-related impacts (e.g. climate change, acidification), toxicity-related impacts (ecotoxicity, human toxicity), and effluent-related pressures such as eutrophication.

Long-term

Over time, LCA-based approaches should be systematically embedded in wastewater procurement frameworks, gradually expanding assessed impact categories to include resource use, land use, waste generation, stratospheric ozone depletion and photochemical ozone formation. This ensures that wastewater solutions are evaluated holistically across their entire life cycle and aligned with long-term environmental and climate goals.

NURSECOAST-II PROJECT OUTPUTS IN THE PERSPECTIVE OF NATIONAL AND INTERNATIONAL STRATEGIES, TARGETS AND HORIZONTAL ACTIONS

NURSECOAST-II translates international, Baltic Sea and European ambitions for sustainable water management, nutrient reduction, ecosystem protection, circular resource use and sustainable tourism into practical solutions for a specific but widely overlooked challenge: the seasonal overloading of small wastewater treatment systems in coastal tourist areas.

A. International level

Framework	Target / strategic objective	NURSECOAST-II contribution	Recommended policy action
UN SDG 6 – Clean Water and Sanitation	By 2030, improve water quality by reducing pollution, halving untreated wastewater and substantially increasing recycling and safe reuse (Target 6.3). Promote integrated water-resource management (6.5).	Wastewater treatment solutions, reuse, monitoring, GIS/data and nutrient reduction	Treat seasonal wastewater management as part of water-quality and resource-reuse policy, including at local level.
UN SDG 12 – Responsible Consumption and Production	Improve resource efficiency and sustainable management/use of natural resources.	LCA, wastewater reuse, resource recovery and business models	Include life-cycle and resource-efficiency criteria in wastewater investment decisions.
UN SDG 13 – Climate Action	Strengthen resilience and adaptive capacity to climate-related hazards.	Flexible treatment systems, nature-based solutions and infrastructure adaptation	Assess wastewater infrastructure against both climate risks and seasonal tourism peaks.
UN SDG 14 – Life Below Water	Prevent and significantly reduce marine pollution from land-based activities.	Nutrient-load reduction from coastal wastewater	Explicitly include small and seasonal wastewater sources in marine pollution reduction programmes.
Global Biodiversity Framework	By 2030, reduce nutrient losses to the environment by at least 50% and reduce pollution to levels not harmful to biodiversity.	Nutrient removal and nature-based treatment	Link wastewater investments to biodiversity and ecosystem objectives rather than treating wastewater as a separate sector.

NURSECOAST-II PROJECT OUTPUTS IN THE PERSPECTIVE OF NATIONAL AND INTERNATIONAL STRATEGIES, TARGETS AND HORIZONTAL ACTIONS

B. Baltic Sea level

Framework	Target / strategic objective	NURSECOAST-II contribution	Recommended policy action
HELCOM BSAP 2021	Achieve a healthy and resilient Baltic Sea; Baltic Sea unaffected by eutrophication; concrete measures by 2030.	Nutrient reduction, pilots, monitoring, policy recommendations	Recognise coastal wastewater as one component of the regional nutrient-reduction effort and integrate NURSECOAST-II solutions into national implementation.
HELCOM Nutrient Reduction Scheme	Meet Maximum Allowable Inputs (MAI) and country/sub-basin Nutrient Input Ceilings (NIC).	Reduction of N/P discharges	Where appropriate, quantify wastewater contributions to national/sub-basin nutrient ceilings and include seasonal loads in assessments.
EUSBSR Policy Area Nutri	Reduce nutrient inputs and eutrophication in the Baltic Sea.	Almost the entire NURSECOAST-II intervention logic	Use NURSECOAST-II as an implementation example for small/seasonal nutrient sources.
EUSBSR Policy Area Tourism	More sustainable, resilient and environmentally responsible tourism.	Addresses infrastructure pressure created by tourism seasonality	Make wastewater capacity and environmental carrying capacity part of sustainable tourism planning.

NURSECOAST-II PROJECT OUTPUTS IN THE PERSPECTIVE OF NATIONAL AND INTERNATIONAL STRATEGIES, TARGETS AND HORIZONTAL ACTIONS

C. European Union level

EU-Framework	Target / strategic objective	Recommended policy action
Water Framework Directive (2000/60/EC)	Prevent deterioration and achieve good ecological and chemical status of surface waters; integrated river-basin management.	Integrate seasonal wastewater pressures into RBMPs and programmes of measures.
Urban Wastewater Treatment Directive (EU) 2024/3019	Stronger wastewater collection/treatment requirements, including nutrient removal and resource/circularity objectives.	Ensure coastal wastewater planning anticipates the new requirements and considers seasonal loading.
EU Biodiversity Strategy 2030	Expand protection/restoration and reduce pressures such as pollution.	Link wastewater nutrient reduction to biodiversity/ecosystem restoration objectives.
EU Zero Pollution Action Plan	Reduce pollution and nutrient losses; move towards zero pollution.	Include wastewater nutrient emissions in local/regional zero-pollution measures.
EU Circular Economy Action Plan	Reduce resource consumption and promote circular resource flows.	Promote water reuse, nutrient recovery and resource-efficient treatment.
EU Climate Adaptation Strategy	Build a climate-resilient EU and strengthen adaptation.	Make resilience a criterion in wastewater infrastructure investment.
EU Tourism Transition Pathway / Tourism Agenda 2030	Green transition, digitalisation, resilience, inclusion and improved governance; reduce tourism's environmental footprint and address seasonality.	Connect tourism-development planning with wastewater carrying capacity and infrastructure.
EU Water Reuse Regulation	Establish minimum requirements for safe agricultural irrigation using reclaimed water.	Consider reuse as an alternative to discharge where environmentally and economically appropriate.

NURSECOAST-II addresses the wastewater management challenges faced by rural coastal areas in the Baltic Sea region, where tourism surges in the summer months place significant pressure on small wastewater treatment plants (<2,000 PE). These systems, designed for the small year-round populations, often struggle to maintain the required effluent quality, which can lead to environmental degradation and reduce the attractiveness of tourist destinations. Tourism is a key economic driver for rural coastal areas around the Baltic Sea, but its growth also increases water consumption and wastewater production. It is estimated that 70–80% of the total water supply becomes wastewater and is released into natural waterways. As water becomes contaminated, it poses a threat to health and the environment, subsequently losing its aesthetic and economic value (Chitthaluri et al. 2023).

To address these issues, NURSECOAST-II is testing six pilot solutions, that combine new technologies and nature-based approaches to improve wastewater treatment and explore alternative uses for treated water, such as irrigation. The results of these pilots form the basis for this document, providing insights and recommendations for more sustainable wastewater management in tourism-heavy coastal regions of the Baltic Sea.

More information about the project can be found at: interreg-baltic.eu/project/nursecoast-II

Role of Transnational Cooperation

Transnational cooperation plays a crucial role in enhancing small wastewater treatment plants across the Baltic Sea Region by enabling countries to share knowledge, pool resources, and develop innovative solutions. Given that wastewater management is a common territorial, economic, and social challenge, collaboration allows regions to tackle issues that work towards a common goal: reducing nutrient input into the Baltic Sea.

By working together, countries can achieve greater impact than through individual efforts. It encourages mutual learning, helping regions benefit from their similarities while leveraging their complementary strengths. Additionally, transnational collaboration broadens perspectives, allowing local stakeholders to see their challenges with "new eyes" and encouraging innovation. It also fosters a stronger connection to European initiatives, increasing awareness of EU actions and shared environmental goals, ensuring that solutions are widely applicable. The geographic and cultural ties among Baltic Sea countries, who share one sea, provide an excellent foundation for coordinated efforts in wastewater management, ultimately benefiting both local communities and the broader region. Therefore meeting not only national targets, but also international or macroregional targets.



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