

MUNICIPAL ENVIRONMENTAL GOVERNANCE MONITORING IN LATVIA: TOWARDS VERTICAL AND HORIZONTAL INDICATORS SYSTEM

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Abstract

Municipal Development Programs cover a wide scope of policies, but environmental governance monitoring has been weak. After the 2021 reform with aggregation of municipalities in the country, the situation started gradually improving. Considering the voluminosity of Environmental Governance sector and its tendency to grow, there is a need to review the set of monitoring indicators. The aim of study was to evaluate the monitoring practices in Environmental Governance sector for all 3 basic administrative levels in Latvia (municipal, regional, national), carrying out an analysis of both vertical and horizontal integration and aggregation, and finally, to develop recommendations for municipal monitoring programs and system. The document studies methods were applied. All statutory planning documents (three main documents of each municipality) were reviewed of 7 municipalities of Riga planning region. Besides document studies in Kekava municipality, detailed semi-structured interviews were conducted with municipal experienced specialists. There are accounted for around 80-100 comparatively unique indicators in total. The best monitored are Communal Infrastructure Sector and Climate Change Management Sector (also many various infrastructure indicators) with 54 and 50 indicators respectively, which have high continuity also with higher level documents and good linkages horizontally between municipalities. All planning documents mention reducing GHG emissions, air pollution, green infrastructure etc. During this project study the related recommendations for all sectors were prepared, both for particular case of Kekava municipality and in general for municipal monitoring systems.

Keywords: development program, indicators in the planning process and documents, public monitoring.

Introduction

The value of environmental indicators was emphasized already in the 1970s, highlighting their role in neighbourhood decision-making and guidance to municipalities (Berenyi, 1972). Early recognition of indicators as a bridge between technical data and policy action laid the groundwork for modern municipal sustainability metrics. More recently, there is available already wide literature on various case studies and best practice examples in different countries across a globe, e.g. like the one case study conducted in Palmela, Portugal, (Moreno-Pires & Fidelus, 2012) showing how well-designed local indicator systems can also foster collaborative governance, strengthen institutional capacity, and not only to track well the long-term environmental performance at the municipal level.

Various studies provide insight into sustainability indicators in municipalities, especially urban and smart cities. The bibliometric and taxonomic analyses reveal a growing emphasis on circular economy, climate resilience, and digital infrastructure within urban indicator frameworks (Tomadon et al., 2024). These sources also demonstrate how emerging technologies and data-driven instruments are shaping next-generation sustainability assessments, particularly in fast-growing urban areas. For example, producing the Assessment of Sustainability of Cities in South Korea (Hong et al., 2019), based on a national framework, combining mandatory and voluntary indicators to monitor municipal performance, acquired findings highlighted the importance of adapting indicator systems to specific governance contexts while maintaining consistency across regions. The study underscores how such systems, when institutionalized, can help municipalities balance environmental, economic, and social goals effectively.

Nowadays municipal environmental indicators have become an essential instrument for assessing sustainability and guiding urban policy, but just the matter still is how those indicators and/or their systems have been developed, implemented and monitored. Unfortunately, by pragmatic approaches-based and in limited capacities functioning, local municipal practice situation still could be improved also in high-developed countries. For such a conditions, exactly the bottom-up approach for developing and monitoring of indicators - where local communities and stakeholders actively participate - can significantly enhance the relevance and acceptance of environmental management strategies (Criollo et al., 2019) For example, the case study in Colombia produced 40 practical indicators that reflect local socio-environmental priorities, providing a replicable model for participatory governance in other municipalities (Criollo et al., 2019). In other regions and particularly in Europe there are to be found rich diversity of various best practice examples.

While international research demonstrates a wide range of approaches to developing and applying municipal environmental indicators, it is crucial to examine how these insights align with the context of Latvia. Given Latvia's administrative structure, environmental challenges, and growing emphasis on sustainable development, assessing the current use of indicators at the municipal level can reveal both strengths and gaps.

In Latvia, 7-year municipal Development Programs (DP) are the key documents for **socio-ecological system (SES) development**, integrating sectoral policies. It possesses also related monitoring of the program implementation. However, this monitoring planning and practice, particularly, **environmental governance sector monitoring**, has been **still in**

necessary further development stage, including type, number and especially adherence not only to main actionable dimensions, but main work directions etc. even after the administrative-territorial reform 2021 reducing number of municipalities from 119 to 42, seen gradually however unevenly improving.

All statutory planning documents (three main documents of each municipality) were reviewed for 7 municipalities of Riga planning region (RPR) as one of five planning regions in Latvia, - Adazi, Ropazi, Salaspils, Kekava, Olaine, Marupe municipalities and Jurmala city municipality.

Monitoring and evaluation of development planning documents at all administrative-management levels is essential for their effective implementation as required by the Law on Development Planning system (2009). Statutory required monitoring reports reflect the actions taken, the indicators of results achieved, and the progress made toward the set objectives during the reporting period. The evaluation process for the implementation of the municipal development programme requires the preparation of an annual monitoring report on the programme's implementation, as well as a three-year review report. In the course of the work, monitoring practices and their continuity at 3 administrative/management levels were studied - national (Latvian Sustainable Development Strategy until 2030 - LSDS, the National Development Plan of Latvia for 2021-2027 - NDP, Environmental Policy Guidelines for 2021-2027 - EPG), regional (Riga Planning Region Development Programme – RPR DP) and local (municipal Development Programmes - DP). The aim of the study was to collect, assess and evaluate the monitoring practices in the Environmental Governance sector for all 3 basic management levels in Latvia (municipal, planning regions, national), carrying out qualitative analysis of both vertical and horizontal integration and aggregation, and finally, to develop a set of system recommendations for the municipal monitoring programs and system. The problem is that municipal development programs have a wide scope of actions, but monitoring has been comparatively weak until the administrative-territorial reform even in 2021. Considering the size of the environmental management sector and the tendency to grow, it is necessary to evaluate the monitoring procedures and content, towards the increase of its effectiveness.

Local municipalities play a key role in environmental governance, as they are responsible for implementing national and regional policies at the local level, while also addressing local sustainability challenges. As sustainability challenges become more complex, municipalities must strengthen their governance frameworks, improve strategic planning, and enhance monitoring mechanisms to ensure that environmental policies are both effective and adaptable to evolving climate and societal needs (Guyadeen et al., 2023).

Public engagement in environmental governance enhances transparency, accountability, and decision-making (VARAM, 2015, 2022; Azevedo et al., 2025). However, for public participation to be meaningful, it must be supported by well-structured environmental governance frameworks that ensure the efficient coordination of policies across different levels of government. Effectiveness of multi-level environmental governance depends on strong collaboration among local, regional, and national institutions, enabling development of robust sustainability frameworks that guide municipalities in implementing climate and environmental policies (Guyadeen et al., 2023).

To effectively integrate sustainability into governance, municipalities increasingly adopt strategic planning as a proactive approach to anticipate and address complex environmental and climate challenges. This involves defining long-term objectives, identifying priorities, and allocating human and financial resources accordingly. While discussion has taken place regarding the scope, content, and methodology of strategic planning, less attention has been given to the quality of municipal strategic plans (Azevedo et al., 2025). Many local strategies lack crucial components, such as a comprehensive evidence base to justify goals and clear mechanisms for implementation, monitoring, and evaluation. Without these elements, even the best-intentioned policies may fail to achieve their desired impact. Therefore, significant improvements are needed to ensure that municipal planning is cohesive, actionable, and aligned with broader sustainability goals (Lemos & Agrawal, 2006).

Both researchers and policymakers increasingly recognize that local-level actions play a pivotal role in achieving climate change mitigation targets. Municipalities exercise direct control over critical environmental policies, such as land-use regulations, urban development, resource management, and transportation planning, all of which significantly impact sustainability. Additionally, they oversee licensing for buildings, public transport operations, and municipal energy consumption, allowing them to set an example through sustainable practices. Given their proximity to communities, municipalities are also better equipped to understand local behaviours, cultural contexts, and energy consumption patterns, ensuring that environmental policies are not only effective but also socially acceptable and practically implementable (Azevedo et al., 2025).

Recognizing their influence and responsibility, many municipalities have proactively adopted climate action strategies. Over the past decade, more than 6,000 European municipalities have voluntarily joined the Covenant of Mayors, a significant initiative aimed at enhancing climate resilience and promoting local sustainability actions. As climate initiatives continue to expand, it is essential to assess their overall impact.

Evaluating the effectiveness, relevance, and efficiency of municipal climate and environmental policies provides valuable insights for policymakers, facilitates the development of improved governance strategies, and promotes best practices in sustainability. However, accurately assessing these policies remains challenging, as their outcomes depend on multiple external factors, including economic conditions, technological advancements, and national regulatory frameworks (Meadowcroft, 2007).

Local municipalities shall act within a framework of normative documents, but they also can issue their own local regulations and implement voluntary activities, including sectoral development planning as management of waterbodies etc. Functions of local governments in Latvia are described in law, laying down the legal basis, structure, competences and duties of a local government. These functions are directly related with environment governance at local level and form a framework of binding obligations important for local citizens, entrepreneurs and society in general (VARAM, 2022).

There in the new Local Government Law since 2023 and there is included new function of local governments – **to contribute to climate change mitigation and adaptation**. The inclusion of the new function is a response to current global and national challenges related to climate change. It highlights the important role of municipalities in mitigating climate change and adapting to its effects. It helps ensure sustainable development, improve the quality of life for local communities, and fulfil international and national commitments in the field of climate action. Municipalities become key partners in this global challenge, and implementing this function represents a significant investment in the future (Lemos & Agrawal, 2006).

The statutory national environmental laws play role of a second source of legal responsibilities in the environmental sector for municipalities, in addition to the basic law on municipalities and its autonomous functions described below. Various other national regulatory acts impose obligations on local municipalities in different environmental sectors, such as the Waste Management Law, Water Management Law, Spatial Development Planning Law, Air Protection Law, Biodiversity Protection Law, and Climate Change Adaptation Law.

While **municipalities in Latvia are not directly responsible for environmental monitoring**, they play a key role in implementing and supporting national policies (Local Government Law, 2025). Their responsibilities include organizing and overseeing waste management systems, ensuring sustainable land use planning, promoting biodiversity protection measures, and facilitating local initiatives for climate adaptation and environmental awareness. Environmental monitoring, such as air and water quality assessments, biodiversity evaluations, and

pollution control, is carried out by national institutions and agencies, with municipalities often cooperating by providing relevant data, local expertise, facilitating community engagement in environmental protection efforts (Local Government Law, 2025).

The participatory municipal budgeting. There in the new Local Government Law is provided potential financing source for improvement of socio-economical activities in the local communities, but potentially also for nature resources management, water quality, air quality etc. Participatory budgeting is one of the ways to promote public participation in local government, including by fostering cooperation between the two sides, given that it is the citizen who will propose a solution to a problem that is important to him, his community or his territory (Local Government Law, 2025; Azevedo et al., 2025). The objective of participatory budgeting in promoting the development of the territory is not only to implement infrastructure projects, but also to plan the development of the territory in such as to improve the quality of the living environment, make sustainable, efficient and rational use of the territory and other resources, develop targeted and balanced economy. Starting from 2023, the municipality shall provide in the annual budget of the municipality funding for the participation budget of at least 0.1 per cent of the average annual personal income tax and real estate tax revenues of the municipality, calculated for the last three years. Thematic scope of the participatory budget and expected results of projects proposed by the public are defined by municipality in the development programme, including considering the needs of the population (Local Government Law, 2025).

Materials and Methods

During the development of this study, the environmental governance monitoring practice and its continuity were studied at all the **3 administration/planning levels in Latvia**. The Research-and-Development framework was employed to come to actionable policies and indicators development recommendations. **Case Study Research** methodology was used, including, the core study of all related documents, particularly, statutory planning documents at all three administration levels and, complementary, express interviews with 5 experts and municipal specialists from chosen piloting municipality of Kekava (Riga planning region) in relation to the design, approval and implementation of the development planning documents.

The national level was covered by the following development planning documents: LSDS; NDP; EPG. Next level is called planning regions level (governed by the council of chairpersons of all local municipalities of particular region) - Development Program of Riga Planning Region (RPR DP). Further on the Development Programs of local municipalities/governments (DP) were studied.

Latvia 2030 or LSDS is the national long-term development strategy aimed at creating a sustainable, competitive, and balanced society. The strategy focuses on economic growth, social well-being, and environmental protection, aligning with European and global sustainability goals. NDP2027 is Latvia's only overall medium-term development program, guiding policies and investments to ensure economic growth, social well-being, and sustainability. It aligns with EU priorities and focuses on building a smart, green, and inclusive society. The EPG as overall medium-term environmental sector planning document is outlining Latvia's strategic approach to sustainability, climate resilience, and environmental protection. The policy aligns with EU Green Deal objectives and aims to balance economic growth with ecological responsibility. For this investigation was chosen one, the RPR, case, which contains 7 municipalities and Riga capital city, however the statutory development planning documents were examined initially for all local municipalities in Latvia (43 municipalities altogether after administrative-territorial reform of 2021) covering altogether existing 5 planning regions as regional level authorities.

There are in total almost 800 local environmental governance indicators described/found for monitoring of municipal Development Programs to measure the planning implementation progress in all 43 municipalities in Latvia, even main part of those thematic indicators overlaps or are similar. Narrowing the scope of municipalities for detailed studies, the document studies within RPR case was applied and, in total, all the statutory planning documents (three main development planning documents for each municipality – Sustainable Development Strategy, Development Program (incl. also Action Plan and Investment Plan as short-term planning documents) were reviewed of all the 7 municipalities of RPR (except Riga capital city) as one of five planning regions in Latvia, actually most developed one since in direct proximity to the Riga capital city, being by far largest city (above 0.5 milj. inhabitants) in Latvia. The local municipalities studied namely are Adazi, Ropazi, Salaspils, Kekava, Olaine, Marupe municipalities and Jurmala township municipality.

Total area of the examined 7 municipalities is 2 100 km², total number of inhabitants – 223.3 thousand (total number of inhabitants in Latvia – 1.87 million, but in Riga City – 605 thousand, total area of Latvia is 64 594 km²). The RPR is the heart of Latvia's economy and culture, offering a dynamic and diverse environment for business, tourism, and innovation. With a strong infrastructure, skilled workforce, and a strategic location, it plays a crucial role in Latvia's development and integration into the European and global economy.

Special attention was paid to the Action Plans and Surveillance Plans for the Development Programs, which contain the main lines of action, priorities for

different time periods, tasks, expected results as well as monitoring indicators. For the necessary overall framing and content wise structuring of the municipal Environmental Governance branch itself and its monitoring indicators analysis, three main environmental governance sectorial dimensions were used (actually, already four dimensions now, but newly approaching climate change management issues are to be more sectorized and prescribed now) as the basic set of sectorial dimensions grouping model:

1. **Environmental Infrastructure** sectorial dimension as all the mandatory communal services/u sectors as prescribed by the Local Government Law (municipal autonomous responsibility functions) and very well-known in practice and quite well implemented in the municipalities.
2. **Environmental Protection** sectorial dimension as voluntary and ever-growing number of new environmental sectors (actually, also instruments) besides those statutory municipal infrastructure autonomous responsibility functions.
3. **Environmental Governance and Environmental Communication** sectorial dimension as known from models and our previous research papers, finally nowadays are increasingly taking place in the municipal overall/sectorial development planning documents and procedures, however still not fully prescribed by regional and particularly national authorities and/or voluntarily developing.

However, in pragmatic sectorial understanding of municipal practice is step-wise developing and the model of **8 thematical sectors of environment governance content spectrum** was chosen (Natural Environment, Urban Environment, Communal Environment, Environmental Protection, Health Environment, Climate Change Management, Communication Environment, Governance Environment) as it mainly coincides with municipal law and Environmental Policy Guidelines, as well as DP Planning Recommendations from the Ministry of Smart Administration and Regional Development.

Environment governance monitoring practice audit in Latvia has been realized at all three levels of government and both Action Plans (short 1-3 years planning) and Supervision/Monitoring Planning, as the statutory part of the municipal Development Programs are discussed in particular, as includes the main courses of action, priorities of different deadlines, tasks, expected results, as well as monitoring indicators are found.

Initially national and regional level indicators studies are to be explored, continued by municipal level study of all 7 municipalities of RPR, and finalizing our studies with Kekava local municipality as one of those 7 mentioned, to go into detail of local municipal monitoring, applying research-and-development frame, including recommendations for system and list of municipal indicators, e.g. public monitoring.

Environmental management monitoring practices at the state, regional, and local government levels follow a vertical integration (top-down) approach. This involves reviewing their statutory framework, key policy documents, and specific monitoring reports.

Results and Discussion

1. Environment governance monitoring audit: national and regional level

There are several key environmental management indicators across different levels of governance in Latvia, including LSDS, NDP2027, RPR DP2027, and EPG2027. While national policies set the overall framework, regional and municipal plans tailor environmental strategies to local needs, ensuring a comprehensive and integrated approach to environmental governance.

Key environmental management indicators used at different governance levels in Latvia—national, regional, and municipal, cover a wide range of environmental sectors, including nature conservation, urban environment, communal services, environmental protection, public health, climate change management, communication, governance, and other environment-related sectors. These metrics provide insight into the priorities and strategic directions of institutions regarding sustainability, resource efficiency, and climate action goals.

Closer look reveals that nature conservation indicators primarily focus on protected areas, biodiversity, and the efficient use of natural resources. They reflect progress in areas such as forest coverage, organic farming expansion, and the conservation status of protected species and habitats. In contrast, urban and communal environment indicators emphasize waste management, water supply quality, and access to essential resources such as clean drinking water. National-level documents tend to outline broader strategic goals, while regional and municipal plans set more specific targets and implementation measures.

Particularly significant section is climate change management, which includes greenhouse gas (GHG) emission reduction, renewable energy usage, energy efficiency improvements, and public transport development. These indicators are crucial in context of the European Union's climate policy, as they determine Latvia's ability to meet the Green Deal objectives and reduce dependence on fossil fuels. Additionally, governance and communication aspects highlight importance of digitalization, public access to environmental information, and private sector involvement in environmental management.

In the natural environment sector, in all the documents considered (LSDS, NDP, EPG, RPR DP), the share of specially protected nature territories is mentioned as an indicator, which is important for following the European Union's Green Deal and increasing the area of specially protected nature areas to 30%.

In the communal environment sector, all documents except the NDP pay special attention to the share of recycled, sorted waste, with the desire to increase the amount of sorted waste.

In the environmental protection sector, the EPG mentions soil radioactivity monitoring and seismic process monitoring, and LSDS mentions the need to monitor the inflow of nitrogen/phosphorus compounds into surface freshwater bodies, whereas nothing was found in the NDP and RPR DP.

In the health environment sector, monitoring indicators were found only in the EPG, which includes premature deaths due to air pollution and the number of residents receiving drinking water of adequate quality. The climate change management sector is the widest, it has the most monitoring indicators, all documents talk about reducing GHG emissions, air pollution, green infrastructure are also mentioned, the RPR DP has several indicators related to shared cars, public transport, regional cycling infrastructure, etc. Both LSDS and RPR DP, the share of energy from renewable sources is mentioned but no such indicators were found in the other documents.

In the communication environment sector, the monitoring indicator was found only in the EPG, which is related to environmental noise, so that citizens have access to high-quality information about noise sources and their impact on objects related to industrial activity. In the management environment sector, the LSDS mentioned a monitoring indicator related to the use of e-government, while the RPR DP mentions an indicator on the basic budget expenditure of the region's municipalities for the management of territories and housing, as well as on sustainable energy development strategies in households.

In general, it can be concluded that environment indicators in national level are set in accordance with basic EU requirements, they are monitored mostly by state company Latvian Environment, Geology and Meteorology Centre (LEGMC). Results of monitoring are available publicly on the LEGMC website but information about such availability is not channeled to local level municipalities and general public.

Regional level planning documents are less populated with environmental indicators somehow leaving this issue for both national and local level. This may be related to limited capacity of regional level planning institutions in terms of finances and human resources practically restricting any monitoring activities in regional level except statistics collected both at national and local level.

2. Environment governance monitoring audit: local municipal level

Environmental monitoring indicators across various municipalities within Latvia indicators are categorized under key areas such as nature conservation, urban environment, communal services, environmental protection, public health, climate change management,

communication, and environmental governance. Each municipality's progress is assessed through quantifiable measures such as forest coverage, biodiversity protection, waste management efficiency, water quality assessments, renewable energy adoption, and urban development projects. By comparing these indicators across different municipalities, there can be seen the regional variations in environmental efforts and strategic planning. In total, around 200 various indicators have been compiled from the DP of those 7 local municipalities studied but given that many of them are quite the same or similar, there are reviewed around 80-100 comparatively unique indicators in total (in some cases only the scope differs). The municipal DP pay most attention to - length of cycling paths, improvement of municipal areas, energy efficiency of buildings, centralized infrastructure pipeline systems (water supply, wastewater collection, heating).

A notable aspect is the diverse level of data availability across municipalities, where some have detailed monitoring indicators while others lack reported data. For example, Adazi and Ropazi municipalities provide extensive indicators related to nature protection, waste management, and water supply, whereas Salaspils, Olaine, and Marupe have fewer reported metrics in several categories. In the table, Kekava municipality has reported indicators in urban environment, communal services, climate change management, and environmental governance, but lacks data on nature conservation, environmental protection, and health environment. Key focus areas include urban infrastructure, such as public parks and cycle paths, as well as waste management, with indicators on waste sorting and composting areas. Additionally, Kekava tracks water supply and wastewater connections, while its climate change management efforts focus on renewable energy use, public transport availability, and energy efficiency in buildings. This highlights the municipality's emphasis on urban sustainability and infrastructure development, while certain environmental aspects remain unreported. Additionally, climate change management indicators highlight municipalities efforts in GHG emissions reduction, public transport development, and energy efficiency improvements, reflecting their commitment to sustainable urban planning. Furthermore, governance and communication indicators emphasize the role of citizen engagement, digital services, and environmental awareness campaigns. Overall, this table serves as a valuable instrument for assessing and comparing environmental policies and progress at the local government level, helping to identify strengths, gaps, and potential areas for improvement in environmental sustainability strategies.

3. Environmental governance indicators: new sectors practice to be further developed

It is essential to ensure that all municipal environmental goals are measurable, achievable, and aligned with national and EU policies. By bridging the

eventual monitoring gap, integrating environmental goals into strategic planning, strengthening public participation, ensuring regulatory compliance, and enabling data-driven decision-making, it would significantly enhance environmental governance and support the long-term municipal sustainability.

As definitively one of the most positive, even not perfect, examples shall be mentioned the full spectrum list of environmental management performance indicators in the DP of Adazi Municipality (RPR). While the number of environmental governance indicators is high (39), without sufficient data collection, monitoring frameworks, and performance evaluations, becomes challenging to assess the actual progress toward environmental goals.

Particularly interesting is to recognize and to follow to the developments of comparatively new environmental governance sectors/fields being in development recently. Here we would like to mention first Governance and Communication sectors of environmental management as to be more and more recognized as sectors to be emphasized out of other more traditional environmental management sectors (water, waste etc.). Also, Climate Change Management sector as developing both with bottom-up interest from municipalities itself, as well as, per growing top-down requirements by national level planning institutions. It is to be mentioned already known for long Environmental Protection sector, but here is to be considered, that municipalities most often still use in practice, so called, Communal Infrastructure sector (traditional and mandatory water and wastewater, waste and heating sectors), but those Environmental requirements being beyond Communal ones are summarized under Environmental Protection. In the Table 1 there is summarized list of indicators of those four above mentioned sectors newcomers as a collection from all 7 municipalities of this study.

The Governance sector focuses on the development and implementation of strategic plans and initiatives that promote sustainable environmental management at the municipal level. Key indicators include creation of thematic and local plans, participation in environmental governance and tidy environment contests, promotion of environmentally friendly companies. Municipal support mechanisms such as co-financing, and electronic services are also emphasized. Civic participation is encouraged through participatory budgeting, citizen initiatives, and neighbourhood organizations. International cooperation and resident satisfaction are monitored to ensure accountability and ongoing improvement in governance quality.

The Communication sector emphasizes environmental information, environmental education, public engagement and pro-environmental behaviour. Indicators track the effectiveness of public awareness efforts, such as environmental education programs, awareness campaigns, and community events. The availability of electronic municipal services is

assessed, along with collaboration with schools and community groups. Clean-up initiatives, eco-contests, and the promotion of environmentally friendly companies further strengthen environmental consciousness. The sector also monitors how well residents understand environmental challenges, helping to shape more effective outreach and educational strategies.

The Climate sector indicators measure progress in reducing greenhouse gas emissions and improving energy efficiency. These include efficiency of heat production, use of alternative energy sources, and

energy consumption in public and residential buildings. The sector also evaluates CO₂ emissions, type of fuel used, and share of renewable energy, highlighting sector's integrated approach to mitigating climate change.

The Environmental protection sector monitors the state and protection of natural resources and biodiversity. Indicators include flood risk exposure, water quality, and presence of stormwater systems. Community-based environmental projects, Blue Flag beaches, and urban forests enhance ecological health.

Table 1

Environmental management indicators of the Riga planning region municipalities: four newcomers' sectors

<i>Sector by indicator</i>	<i>Sector by indicator</i>
<p>Governance sector indicators</p> <ol style="list-style-type: none"> 1. Thematic and local plans developed 2. Projects from various environmental governance and municipal competitions 3. Tidy environment contest participants 4. Environmentally friendly companies 5. Land use classification 6. Energy efficiency cost compensation 7. Neighbourhood organizations count 8. Ongoing international cooperation projects 9. Population assessment of territorial development 10. Local government engagement opportunities 11. Municipal co-financing initiatives 12. Number of electronic municipal services 13. Participatory budgeting efforts 14. Citizens' initiative projects implemented annually 15. Resident satisfaction with municipality 	<p>Communications sector indicators</p> <ol style="list-style-type: none"> 1. Residents' view of drinking water quality 2. ECO education programs in the municipality 3. Percentage of municipal e-services available 4. Environmental awareness campaigns 5. Environmental events (lectures, discussions) 6. Updates on pressing environmental problems 7. Cooperation with schools and groups on environmental initiatives (contests, events) 8. Community involvement in clean-up activities 9. Projects implemented through competitions 10. Participants in tidy environment contests 11. Number of eco-friendly companies 12. Number of neighbourhood areas organizations 13. Ongoing international cooperation projects 14. Public awareness on environmental issues
<p>Climate sector indicators</p> <ol style="list-style-type: none"> 1. Heat production efficiency 2. Pro-environmental/alternative energy production 3. Natural gas consumption in municipal buildings 4. Annual primary energy consumption reduction in public buildings 5. Annual greenhouse gas reduction in public buildings 6. Energy efficiency in multi-apartment buildings 7. Emissions from boiler houses and industrial sources 8. Transport infrastructure to prevent traffic congestion 9. Energy efficient municipal and apartment buildings 10. Carbon dioxide emissions (t/year) 11. Type of fuel used for heat production 12. Construction of stormwater drainage systems 13. LED street lighting installations 14. Average electricity and energy consumption in municipal buildings 15. GHG emissions and share of renewable energy 16. Share of low- and zero-emission vehicles in the fleet 17. Co-financing, improving housing energy efficiency 18. Information on energy efficiency and renovations 	<p>Environmental protection sector indicators</p> <ol style="list-style-type: none"> 1. Number of people exposed to the floods threat 2. Good water quality (ecological and chemical) 3. Stormwater drainage and treatment 4. Environmental projects in the community 5. Blue Flag beaches 6. Urban and rural forests 7. Nature projects (parks and waterfronts) 8. Nature and recreational trails 9. Publicly accessible areas near water 10. Percentage of afforested land 11. Registered organic farms 12. Natural areas in the city 13. Limited invasive species 14. Growth in sustainable tourism activities

Nature parks, trails, and accessible waterfronts are promoted to foster public interaction with natural environments. The sector also tracks afforestation rates, organic farming, control of invasive species, and

growth in sustainable tourism, reflecting commitment to preserving both urban and rural ecosystems. Together, these four sectors - governance, communications, climate, and environmental

protection - form a comprehensive framework for additional and more sustainable environmental management at the local level as both – really supporting informed decision-making and promote civic engagement, as well as enhance ecological resilience of municipality as socio-ecological system.

4. Comparison of municipal monitoring practices: vertically and horizontally

Environmental monitoring plays a crucial role in assessing progress toward sustainability and ensuring compliance with national and EU. Analysis of key Latvian strategic documents reveals varying levels of attention to environmental monitoring across different sectors. Some indicators are consistently present across all documents, others are fragmented or missing, highlighting potential gaps in environmental governance.

Natural Environment Sector. The natural environment sector is one of the most comprehensively addressed areas in all four documents. A key indicator across all documents is the share of specially protected nature territories, aligning with the EU Green Deal objectives, which aim to increase protected natural areas to 30% of the total land area. This indicator reflects efforts to enhance biodiversity conservation, preserve ecosystems, and protect endangered species. However, while all documents acknowledge the importance of expanding protected areas, specific implementation strategies and monitoring mechanisms vary, particularly at the regional level.

Urban Environment Sector. The urban environment sector plays a crucial role in shaping sustainable and liveable cities, yet its integration across the four documents varies significantly. While some documents emphasize infrastructure development, others focus on mobility, air quality, and urban green spaces. A key indicator in this sector is the development of cycling infrastructure and pedestrian-friendly urban planning, which aligns with broader sustainability goals, including the EU's Green Deal and local climate action strategies. The RPR DP places a strong emphasis on cycling and shared mobility solutions, whereas the LSDS and NDP focus more broadly on urban infrastructure and energy efficiency. The EPG, however, lacks specific indicators on urban development, which may limit the ability to assess the environmental impact of expanding urbanization. Another notable discrepancy is the absence of clear indicators on air quality monitoring in dense urban areas, despite increasing concerns about pollution-related health risks.

Communal Environment Sector. In the communal environment sector, most documents, except for the NDP, emphasize the share of recycled and sorted waste, underlining the goal of increasing waste sorting rates. This aligns with the principles of the circular economy, where waste management is improved

through enhanced recycling systems and waste reduction initiatives.

Environmental Protection Sector. The environmental protection sector reveals notable disparities between documents. The EPG includes monitoring indicators for soil radioactivity and seismic activity, ensuring public and environmental safety against potential hazards. Meanwhile, the LSDS highlights the necessity of monitoring nitrogen and phosphorus inflows into freshwater bodies, a critical factor in controlling water pollution and eutrophication. However, the NDP and RPR DP lack environmental protection indicators, leaving a gap in addressing pollution control and ecological risk management. This suggests a need for stronger integration of water quality, air pollution, and soil contamination monitoring across all planning documents.

Health Environment Sector. The health environment sector is the least covered, with monitoring indicators found only in the EPG. Key indicators include premature deaths due to air pollution and the number of residents receiving drinking water of adequate quality. These metrics are essential for assessing the impact of environmental factors on public health, particularly given the increasing risks posed by airborne pollutants such as PM2.5 and nitrogen oxides (NOx). The lack of comprehensive health-related environmental indicators in the LSDS, NDP, and RPR DP suggests that the direct impact of environmental conditions on public health is not sufficiently integrated into broader environmental strategies.

Climate Change Management Sector. Among all sectors, climate change management is the most extensive, featuring the largest number of monitoring indicators. All four documents highlight reducing GHG emissions and air pollution, which aligns with Latvia's commitments under the Paris Agreement and the EU's climate neutrality targets. Additionally, green infrastructure development is a recurring theme. The RPR DP introduces a range of specific indicators, including shared mobility solutions, public transport development, and regional cycling infrastructure, indicating a strong focus on sustainable transportation. However, renewable energy monitoring is only included in LSDS and RPR DP, whereas NDP and EPG lack indicators on renewable energy adoption, a key component in achieving climate neutrality. This suggests that national-level documents should better integrate renewable energy strategies into climate change policies.

Communication Environment Sector. In the communication environment sector, the EPG is the only document that includes a monitoring indicator, specifically related to environmental noise. The aim is to ensure that citizens have access to high-quality information on noise sources and their impact on industrial and urban areas. Given that noise pollution

is an emerging public health concern in urbanized areas, the absence of communication-related environmental indicators in other documents limits public awareness and engagement in environmental issues. Expanding this sector's monitoring framework could help improve citizen participation in environmental decision-making and ensure transparency in policy implementation.

Environment Management Sector. The environment management sector reflects governance and financial aspects of environmental sustainability. The LSDS includes a monitoring indicator for individual e-government usage, reflecting efforts to digitize administrative services and improve public access to environmental information. The RPR DP, on the other hand, includes indicators on basic budget expenditures for municipal environmental management and sustainable energy development strategies. These indicators highlight the role of governance and financial planning in ensuring long-term environmental sustainability. However, the absence of governance-related indicators in the NDP and EPG suggests that strategic financial planning and governance efficiency need further emphasis at the national level.

Analysis of environmental monitoring indicators across key strategic documents highlights both well-integrated focus areas and notable gaps in Latvia's environmental governance framework. While biodiversity conservation, climate change management, and waste sorting receive significant attention, public health, environmental protection, and renewable energy monitoring are inconsistently addressed. Lack of certain indicators in key national documents such as the NDP raises concerns about policy alignment and implementation effectiveness. Strengthening environmental monitoring across all governance levels is essential for achieving Latvia's long-term sustainability goals and fulfilling international environmental commitments. A more harmonized approach across national, regional, and municipal policies would ensure more comprehensive environmental planning, stronger public engagement, and enhanced sustainability outcomes.

5. Municipal environmental monitoring: Kekava local municipality case

Kekava Municipality is in the central part of Latvia, south of Riga, making it an important suburban area within the RPR. Due to its proximity to the capital, Kekava has experienced significant economic and demographic growth, serving as both a residential area and a business hub. The municipality covers an area of approximately 270 km² and has a population of around 24,000 residents, making it one of the larger municipalities in the region. The Daugava River flows through its territory, contributing to its natural and ecological value, while also presenting flood risk management challenges. Budget of Kekava municipality in year 2025 is 99.3 million EUR,

including 0.25 million EUR devoted to the participatory budget.

The municipality consists of several towns and villages, with Kekava town as the administrative center. The economy is driven by manufacturing, trade, and logistics, with many businesses benefiting from the municipality's strategic location near major transport routes, including the A7 highway and Via Baltica corridor. Environmental considerations are crucial for municipal planning, as the rapid urbanization poses challenges in waste management, air quality, and green space preservation.

Kekava Municipality Planning Documents. Kekava Municipality Sustainable Development Strategy 2014–2030: This long-term planning document outlines the municipality's strategic vision, goals, and priorities for sustainable development up to the year 2030. It serves as a foundation for all subsequent planning and development activities within the municipality. Kekava Municipality Development Program 2020–2026: This medium-term planning document details specific objectives, tasks, and measures to be implemented between 2020 and 2026. It translates the strategic goals from the Sustainable Development Strategy into actionable plans, focusing on various sectors such as infrastructure, education, social services, and environmental protection. Kekava Municipality Spatial Plan 2019–2031: This spatial planning document defines the municipal land use policies and regulations for the period 2019–2031.

Following the administrative territorial reform in 2021, Kekava Municipality incorporated the former Baldone Municipality. This expansion necessitated updates to existing planning documents to reflect new administrative boundaries and integrate development priorities of the newly included territories. The municipality undertook a comprehensive review and amendment process to ensure that all planning documents accurately represent the expanded municipality's needs and aspirations.

As any municipal DP, Kekava DP has also chapter on DP implementation supervision, including the list of municipal indicators/pointers and, subsequently, **statutory required monitoring reports** measuring the progress made toward the set objectives during the reporting period.

Kekava municipality has good indicators, some directions of activity and monitoring indicators of Kekava municipality coincide with the planning documents of the national level, for example, indicators on forest cover and areas used in organic farming specified in the LSDS nature sector. Kekava municipality has also adapted in the communal sector to the planning documents of the Latvian level, placing emphasis on the share of recycled and sorted waste and paying attention to the reduction of GHG emissions in the climate change sector. Kekava Municipality DP has 4 Medium-term priorities with 2–6 Directions of

Actions; the following recommendations have been developed for their monitoring indicators:

1. Monitoring of natural resources and public outdoor space using the environment planning (EP) approach.
2. Extended monitoring of the social environment can be implemented by monitoring public order and accessibility of the environment.
3. Development in engineering infrastructure and business environment would be more valuable to monitor using target values or to carry out a percentage assessment of progress.
4. Indicators for monitoring governance and communication should be complemented by indicators indicating private sector involvement, citizen satisfaction and the quality of planning documents.

Monitoring program guidelines for Kekava municipality. The table below presents proposals for improving environmental management indicators in DP of Kekava Municipality, integrating new indicators to enhance sustainability and public engagement.

A significant improvement is the inclusion of **public monitoring indicators**, allowing for greater citizen participation in environmental data collection and, potentially, after monitoring communication and discussion and impact ok decision making. These include inventorying rare and protected species, monitoring invasive species, and tracking bird populations in urban areas. The urban environment sector emphasizes better park maintenance, dust reduction on streets, and improving accessibility for people with functional impairments.

In the communal sector new indicators address water quality monitoring, illegal waste dump tracking, and public satisfaction with waste collection services.

The environmental protection sector now includes tracking contaminated and revitalized sites and assessing water body quality.

The health environment sector introduces air pollution monitoring, while climate change management expands to measure GHG emissions from companies, and public transport improvements in both urban and rural areas. Additionally, communication and governance indicators promote environmental awareness campaigns, eco-school initiatives, and direct citizen communication with local authorities. Governance improvements emphasize citizen participation in advisory councils, thematic planning, and international cooperation on environmental projects. These updates aim to strengthen environmental sustainability efforts, increase transparency, and improve overall quality of life in Kekava Municipality. The proposed improvements to environmental management indicators in the Kekava Municipality DP reflect a more comprehensive, data-driven, and participatory approach to sustainability.

The proposed improvements to environmental management indicators in the Kekava municipality DP reflect a more comprehensive, data-driven, and participatory approach to sustainability (Table 2). By integrating public monitoring initiatives, the municipality enhances citizen engagement in environmental stewardship, fostering a more inclusive and transparent governance model. The expanded indicators also ensure better tracking of waste management, climate change mitigation, biodiversity conservation, and air and water quality, aligning with national and EU environmental policies. These additions will not only improve environmental sustainability and resilience but also contribute to a higher quality of life for residents, reinforcing their role as for the forward-thinking, environmentally responsible Kekava municipality.

Table 2

Proposals for improvement of development indicators of environment management in the development program of Kekava municipality, PM – public monitoring

<i>Existing indicators</i>	<i>Additional/proposed indicators</i>
Sector 1. Nature protection environment	
1. Area of forests owned by the municipality(ha) (% of total forest area) 2. Number of registered organic farms in the county	1. Specially protected nature territories in a favourable conservation state 2. Natural capital & ecosystem services, provision 3. PM- Inventory of rare and protected species 4. PM - Deposits of invasive species 5. PM Birds in feeders, public outdoor space 6. PM Accounting for Great Trees
Sector 2. Urban environment	
1. Public parks in each county town (Baldone, Balozi, Kekava) (number)	1. Public parks in towns permanently managed 2. At least conceptual plans have been developed for all public parks 3. Street and road maintenance measures to reduce dust 4. Program implementation to improve apartment buildings courtyards 5. Satisfaction of residents with urban amenities 6. The length of bicycles in towns and outside towns 7. Length of sidewalks, cycle paths for people with functional impairments

Sector 3. Communal environment	
1. Number of connections to the centralised water supply system 2. Connections to centralised wastewater system (Nr.) 3. Waste separation (Nr.) 4. Share of sorted waste (%) 5. Composting areas (Nr.)	1. Amount of composted waste 2. PM - number of illegal waste dumps 3. Composting municipal vegetation waste 4. Results of analyses of water intended for human consumption 5. Results of analyses of treated wastewater 6. Population satisfaction with waste points, quality of service 7. Population satisfaction: centralized water supply and sewerage systems
Sector 4. Environmental protection	
No indicators assigned	1. Nr. of contaminated and potentially contaminated sites, degraded areas 2. Recultivated, purified, revitalized objects (Nr.) 3. Proportion of good and high-water quality water bodies
Sector 5. Health environment	
1. Suitable different types of active recreation opportunities	1. Results of analyses of water intended for human consumption 2. Analysis/monitoring of air pollution (SO ₂ , NO ₂ , PM _{2,5} , PM ₁₀ , C ₆ H ₆)
6. Climate change management	
1. Public transport routes (Nr.) 2. Renewable energy resources-based boiler houses (Nr.) 3. Electricity consumption per household (kWh/year) 4. Municipal buildings energy consumption (kWh/m ² /y) 6. Length, cycle paths (km) 7. SEG emission	1. Renewables yearly percentage - primary energy consumption sources 2. Greenhouse gas emissions (CO ₂ , CH ₄ , N ₂ O, SF ₆ , HFC, PFC) 3. Greenhouse gas emissions per capita 4. Amount of greenhouse gases sequestered 5. Public transport routes in cities (Nr.) 6. Public transport routes in rural areas (Nr.) 7. GHG emissions from companies 8. Climate change adaption practice developments (to account and specify, e.g. free public access drinking water station/network spread etc.)
7. Communication environment (information, education, participation, pro-environmental behaviour)	
No indicators assigned	1. Environmental awareness measures (lectures, seminars, info days) 2. Energy efficiency projects: private (esp. multi-apartment) properties 3. Number of eco-schools 4. Application for direct communication with local government regarding objects that require attention, number of users and applications in it
8. Management environment	
1. Neighbourhood organizations (Nr.) 2. International cooperation projects (Nr)	1. Neighbourhood organizations in environmental management (Nr.) 2. Number of projects aimed at environmental development in the county 3. Developed thematic plans, number of concepts 4. Number of local government local plans and detailed plans developed 5. Activity and involvement of inhabitants in citizens' advisory councils 6. Citizens' satisfaction with environmental management

The proposed improvements to environmental management indicators in the Kekava municipality DP reflect a more comprehensive, data-driven, and participatory approach to sustainability. By integrating public monitoring initiatives, the municipality enhances citizen engagement in environmental stewardship, fostering a more inclusive and transparent governance model. The expanded indicators also ensure better tracking of waste management, climate change mitigation, biodiversity conservation, and air and water quality, aligning with national and EU environmental policies. These additions will not only improve environmental

sustainability and resilience but also contribute to a higher quality of life for residents, reinforcing their role as for the forward-thinking, environmentally responsible Kekava municipality.

The findings across the academic and practice literature suggest that municipal environmental management indicators are most effective when not only tailored to local governance territorial SES, structures and participatory processes specifics, but also being as wide and coherent possible aligned, as first, horizontally both with own socio-economic sectors and also indicator systems of neighbouring municipalities, and secondly, vertically with all above

administration-management levels and up to also international ones. Furthermore, historical and contemporary best practice case studies highlight that consistent application practice and institutional support are key to transforming chosen indicators into actionable instruments for sustainable management.

Building environment governance in Latvia, based on these international perspectives, it was important to evaluate how effectively such approaches and principles are reflected in Latvia's own indicator frameworks at national, regional and, particularly, municipal levels, since being theoretically known worldwide in academia for a good while, but still not fully became everyday management practice due to limited capacity of financial and human resources, also limited general public awareness that might require monitoring of specific environmental indicators.

This was recognised also in Latvia, being still in the municipal environmental governance improvement process as due to administrative-territorial reform in 2021 reducing number of local municipalities from 119 to 43 and, subsequently, requesting design and preparations of new statutory municipal development planning Documents – long term Sustainable Development Strategy, mid-term (7 years) Development Program (incl. 1-3 years Action Plan and Investment Plan) and Spatial Planning Program as new opportunities for environmental innovations planning. Actually, 3-4 former neighbour municipalities were aggregated into one, what considerably increased monetary and institutional capacities, also environmental capacities, including, finally, establishing Environmental Protection-Management institutional division. Also, some previous positive environmental management traditions and experiences from separate municipalities were now brought together into the new aggregated municipality.

Current study of all the seven municipalities revealed in total almost 200 environmental management indicators from the statutory DP. However, due to logic overlapping objectives and similar methodologies, the number of accounted unique indicators is estimated to be below 100, with differences mainly in scope rather than distinct monitoring categories. This number of various indicators options do serves as very wide optional indicator experience practice data bank to be communicated between closest neighbours and within their planning region with own specifics, as well to all local municipalities and also above administrative levels, what, unfortunately, is still barely communicated, mutually studied and implemented, so indicators being shared in practice are just most traditional environmental management sectors.

The Communal Environment Sector and Climate Change Management sector are the most thematic spectrum-wide and detailed monitored sectors, with 54 and 50 indicators, respectively. These sectors obviously demonstrate strong continuity with higher-

level planning documents, and good horizontal relationship between municipalities. This indicates that local governments have continued to prioritize traditional communal sectors of waste management, water and wastewater, also energy/heating management, actually as prescribed by Local Government Law. Newly developing Climate Change Management sector have been now rapidly expanding. Municipalities are ensuring that these two sectorial monitoring systems, and to some extent also traditional Nature Protection/biodiversity sector, do align with broader regional, national and international sustainability goals.

Although GHG emissions reduction, air pollution control, and green infrastructure development are included in all planning documents, municipalities in the RPR stand out by integrating mobility-focused indicators, such as car-sharing, public transport development, and cycling infrastructure expansion.

Also, particular detailed analysis of the chosen 1 of 7 municipalities of studied of RPR, being traditionally well pro-environmental, the Kekava local municipality's statutory planning documents, besides comparatively high number (18, as recently there were municipalities with 3-5 environmental indicators) and above average thematic spectrum of environmental indicators, also highlighted some gaps in Environmental Governance sectorial monitoring. There are missing indicators related to Environmental health, also Environmental protection and even traditional Urban environment sectors. Also, several other sectors require further refinement and standardization to provide a more accurate and comprehensive picture of environmental conditions. The sector importantly lacks sufficient indicators to assess environmental governance administrative and communication sectors, which are crucial for ensuring transparency, public engagement, and institutional accountability in environmental decision-making. Particular sectorial indicator recommendations (44 new eventual indicators) were prepared to improve monitoring systems for both Kekava municipality and, indirectly, to Latvian municipalities in general, emphasizing the need for more structured and data-driven environmental governance sector indicators.

There was also seen, that RPR development planning documents take a more holistic approach, especially, to sustainable mobility and urban planning, ensuring that climate action efforts extend beyond emissions reduction to include transport behaviour and infrastructure improvements.

This study highlights the importance of improving environmental monitoring systems across municipalities, ensuring that key sustainability goals are effectively tracked and that municipal policies are better aligned with national and regional strategies. While some sectors, such as climate change management and communal environment, already show strong integration, others require significant

improvements to enhance monitoring quality and policy coordination.

Conclusions

This study analysed key statutory overall development and environmental planning documents at national level, development programs (DP) at regional level for chosen Riga Planning Region (RPR) and all the 7 local municipalities in the RPR. The goal was to assess municipal monitoring developments and alignment between municipal and higher-level planning frameworks, identifying gaps and looking for new sector developments in monitoring, also proposing recommendations to enhance particularly municipal environmental governance monitoring.

1. Alignment of indicators across vertical governance levels. The key national planning documents as well as those of RPR and municipal DP do share a number of common environmental governance indicators. Not all the key and main sectorial indicators due to some objective reasons of data availability, but also due to subjective decision-making, are available and consistently integrated across those 3 governance levels, leading to gaps in monitoring, reporting, comparison and decisions.

2. Continuity of indicators in key sectors. The vertical analysis demonstrated strong continuity in Nature Environment, Communal Environment, and Climate Change Management sector indicators across 3 governance levels. However, general Environmental Management, Health Environment, Communication, and newly developing Environmental Protection sector indicators require both further horizontal and vertical cross-level integration development to ensure complementary and effective tracking and evaluation.

3. Municipal environmental development monitoring priorities. The greatest attention in municipal DPs is traditionally given to urban territory improvements, energy efficiency in buildings, and centralized utility systems, but recently also more for cycling infrastructure. While these priorities contribute to sustainable urban development, they do not comprehensively address all aspects of core environmental management, as even biodiversity conservation, climate resilience, and pollution control often remaining poorly monitored.

4. Local monitoring limitations due to national and regional planning. The inclusion of environmental quality and management indicators in municipal DPs is often restricted by the presence or absence of related criteria in national and regional planning documents. The lack of consistent data collection and reporting systems makes it difficult for municipalities to develop also comprehensive risk and resilience strategies.

5. Gaps in the new environmental health, communication, environmental protection sector indicators. In general, for municipal level, there are missing or inadequately defined indicators in the Health Environment, Climate Change Management (besides Energy sector), Communication Environment,

and Environmental Protection sectors.

6. Limited public information, public and private sector involvement. The weakest areas in municipal DPs are public information dissemination, citizen engagement, private sector involvement, and environmental data collection in general. Households and businesses have significant impact on greenhouse gas emissions, but municipalities lack access to essential data regarding heating technologies, emissions from private sources, and other key environmental indicators. Without better cooperation between municipalities, private sector stakeholders, and national institutions, local governments remain limited in their ability to develop effective environmental and climate policies.

7. Detailed monitoring and upgrade planning for piloted municipality. Environmental management sector in the Kekava municipality have long standing positive development practice, including for development of professional environmental governance capacities. However, this does not match with actual DP prescribing now comparatively limited its implementation monitoring and insufficiency of having the whole spectrum of environmental indicators, also for assessing governance, communication, and public engagement. Interesting that some other RPR municipalities having less environmental capacities, but indicator lists are more comprehensive, however also still incomplete.

8. Administrative and financial capacities for municipal monitoring. When planning the introduction of new indicators and more comprehensive indicator systems, municipalities must evaluate their administrative capacities, technical expertise, and, particularly, also limited financial resources to support long-term environmental monitoring, data collection and data analysis. Obviously, effective monitoring requires many and various resources – **municipal capacities building is the key precondition** as well as overall cross-level monitoring system in the country.

9. Role of public involvement and participation in environmental monitoring. Given the financial and administrative constraints of local governments, municipalities should increase public participation in environmental monitoring to reduce costs and improve data availability. Citizen science experience develops already various multi-thematic monitoring initiatives, but even mono-thematic ones as monitoring water clarity with Secchi disks, tracking algal blooms, or reporting air pollution changes and more sophisticated ones could provide valuable environmental data at minimal cost. Also well-developed network of Green Flag/Eco-schools in Latvia may be first assistance.

10. Municipal indicator systems building and managing. The focus should be on expert and public collaboration in selecting meaningful indicators with balanced coverage across all environmental management sectors and links to socio-economic development,

potentially ensuring alignment with regional, national and EU planning levels. However, a unified mandatory core (and voluntary) indicators for cross-sectorial and cross-vertical monitoring system development in the country is required. This may save various resources, also financial ones, and strengthen environmental governance systems in Latvian municipalities. This **administrative system precondition** as well as **participatory precondition**, based on public monitoring, participation,

and improved coordination are essential for driving measurable, data-based sustainability decisions.

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