Crossing Borders, Closing Loops: Solving Eurodelta's Sustainability Challenge through Circularity and Collaboration

(In The Context Of Asset Project)

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INTRODUCTION

Abstract

The Eurodelta region, a transnational urban network spanning the Netherlands, Belgium, and Germany, faces increasing sustainability challenges. Achieving circular urban development in such a complex and interdependent region requires innovative approaches to governance, spatial planning, and resource management. This thesis investigates how cross-border collaboration and stakeholder engagement can facilitate circularity in the built environment, optimizing resource flows and fostering a sustainable urban future. By analyzing existing governance frameworks, spatial strategies, and best practices, the research aims to design stakeholder arenas and collaborative mechanisms that enhance circular economy integration across borders.

Keywords

Eurodelta, Circular Urban Development, Cross-border Collaboration, Governance, Stakeholder Engagement, Sustainability, Spatial Planning

SITE CONTEXT

What is a Eurodelta region?

The Eurodelta with a population of 40 million people , encompassing **Belgium, Netherlands, and North Rhine-Westphalia, Germany**, is crucial for economic activity with cities like Rotterdam, Antwerp, and Düsseldorf.

Figure 01: Site Context Euro Delta

The Eurodelta's interconnected urban system faces complex sustainability challenges, including resource depletion, urban sprawl, and inefficiencies in waste and material cycles. Theoretical and empirical research suggests that cross-border cooperation is key to closing material loops and creating resilient, circular cities. However, governance fragmentation, regulatory differences, and institutional inertia hinder progress. This thesis explores how spatial strategies and collaborative frameworks can address these issues, promoting circularity in the Eurodelta region.

The ASSET project**,** which stands for '**A S**patial **S**trategy for the **E**urodelta, boosting a circular buil**T** environment', will focus its attention on how to transition into a circular built

environment, since the built environment is responsible for 40 % of CO2 emissions across the Eurodelta.

What is a Circular Built Environment(CBE) ?

A Circular Built Environment offers a path toward addressing the sustainability challenges of urbanized regions like the Eurodelta by optimizing resource use, minimizing waste, and creating resilient cities. Given the region's high population density and industrial activity, CBE principles can significantly reduce environmental impact while promoting economic sustainability.

Relevance to the Eurodelta:

The Eurodelta, presents a significant opportunity to rethink sustainable urban development through the concept of a Circular Built Environment (CBE). The CBE model emphasizes resource efficiency by promoting closed-loop systems in urban planning, construction, and energy management. This aligns with the European Union's Green Deal, which prioritizes carbon neutrality and environmental sustainability.

However, despite the interdependence of the Eurodelta cities—such as Rotterdam, Antwerp, and Düsseldorf—urban sustainability efforts often remain fragmented. While individual cities have adopted elements of circularity, they fail to leverage regional cooperation to maximize resource-sharing and sustainability. This lack of collaboration impedes the region's ability to fully implement circular economy (CE) principles at a cross-border level, thereby undermining the collective potential for achieving environmental goals.

Problem Statement

"Despite the Eurodelta' s interconnected economies, there is a **lack of cross-border collaboration on circular urban development**. "
Local circular economy efforts, such as Rotterdam's material reuse initiatives, prove insufficient without a larger, cohesive strategy that aligns with the **EU Green Deal's vision** for a Circular Economy framework, i.e., **Zero Emissions by the year 2050.**

Key Driving Points:

1. *Interconnected economies, but isolated efforts (Rotterdam)*
2. *Environmental challenges require joint action*

3. *Lack of a cohesive framework*
4. *EU Green Deal*
5. *Need for aligned regional policies*
6. *Cross-border efforts beneficial for all*

METHODS

Table1: Research Questions

RESEARCH QUESTION	OBJECTIVE	SIGNIFICANCE
1. How can cross-border collaboration enhance the adoption of Circular Built Environment principles in the Eurodelta?	Identify collaboration methods in urban planning.	Supports sustainability initiatives.
2. What role do stakeholder arenas play in fostering effective cross-border cooperation for circular urban development?	Design frameworks to unite stakeholders.	Encourages diverse participation.
3. How can urban design interventions incorporate CBE across the borders?	Integrate CBE principles into design practices.	Enhances practical application in Eurodelta.

Main Objective

To design collaborative frameworks and stakeholder arenas that foster cross-border collaboration for circular urban development in the Eurodelta. This aligns local efforts with broader regional and EU sustainability goals, facilitating resource efficiency and reduced waste.

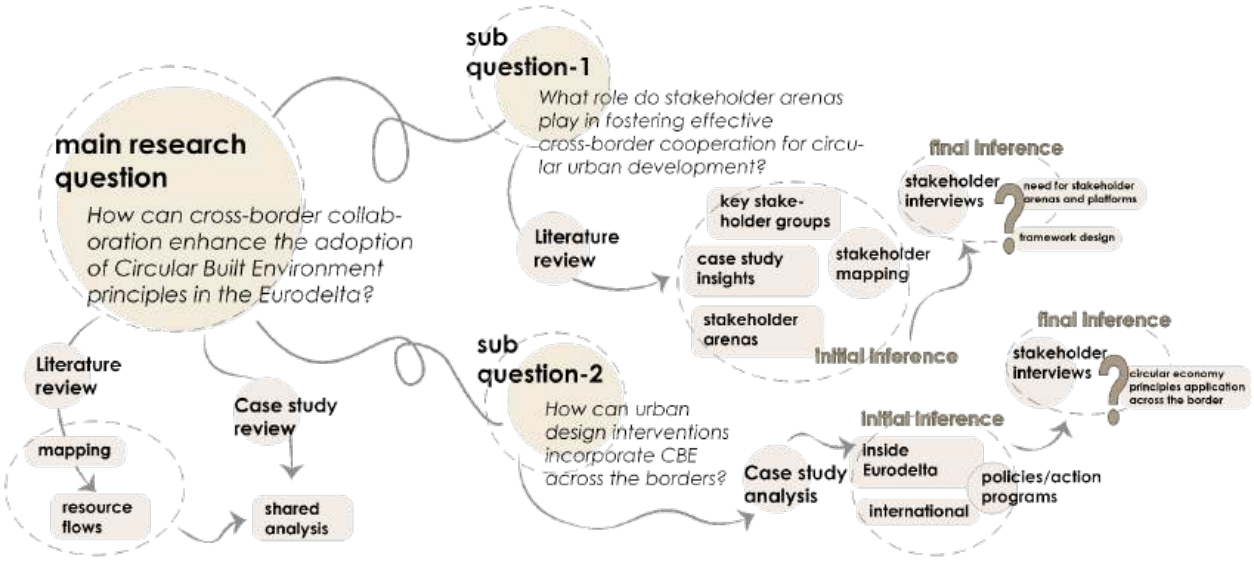

Figure 02: Methodology flow

METHODOLOGY

Outlines the methodological approach used to study cross-border collaboration in the Eurodelta's transition to a Circular Built Environment.

Research methods: *Through a combination of literature reviews, case studies, stakeholder mapping, and spatial analysis, the research aims to identify effective collaboration strategies that enhance sustainability in urban settings.*

The research employs a mixed-methods approach:

1. Literature Review: Examining academic and policy literature on circularity and governance
    - *Focus on CBE & cross-border collaboration*
    - *Key concepts: resource-sharing, stakeholder engagement*
    - *Relevant frameworks: EU Green Deal*
2. Case Study Analysis: Evaluating best practices in cross-border collaboration
    - *Rotterdam's circular material loops, Rhine-Alpine corridor, Amsterdam's Circular Economy Transition and Kalundborg Symbiosis*
    - *Analysis of successful circular initiatives*
    - *Comparison with international examples*
    - *Focus on collaboration outcomes*
    - *Relevance for Eurodelta framework*
3. Stakeholder Mapping & Interviews: Identifying key actors and their roles and engaging experts to validate findings
    - Identification of key stakeholders
    - Local governments, businesses, civil society
    - Conducting in-depth interviews
    - Understanding roles and challenges
    - Diagram of stakeholder network
4. Spatial & Network Analysis: Mapping various layers of urban network and fabric
    - Map resource flows (MFA)
    - Identification of inefficiencies
    - Collaborative opportunities
    - Visualization of resource use patterns

LITERATURE REVIEW

Introduction

The four articles provide a comprehensive overview of sustainable urban development from different perspectives for Multi-Stakeholder Approaches and Circular Economy in Sustainable Urban Development

User-Centered Design in Sustainability Platforms

Paraschivoiu et al. (2020) explore the application of a user-centered approach in developing a digital platform aimed at fostering sustainable urban behavior. Their study involved key stakeholders—including local governments, service providers, and citizens—to collaboratively define system requirements and design elements. The authors argue that integrating urban data into behavior change support systems enhances both personalization and contextual relevance. Furthermore, they emphasize the ongoing nature of stakeholder engagement, underscoring the need for designers to empower all involved actors in the sustainability process. The study suggests that recognizing external behavioral influences creates opportunities to align persuasive digital interventions with broader initiatives, such as infrastructure development (Paraschivoiu et al., 2020).

Circular Economy in the Finnish Built Environment

Karhu et al. (2019) analyze the challenges and opportunities associated with circular economy adoption in Finland's building and construction sector. They argue that achieving a successful transition requires collaboration between diverse stakeholders, including non-traditional partners. However, they highlight key barriers such as resistance to new materials and methods, legislative constraints, and contract models that do not support circularity. A critical finding of the study is that these barriers stem from a lack of life cycle thinking and inadequate coordination (Karhu et al., 2019). The authors discuss a project by The Finnish Innovation Fund Sitra, which sought to increase circular economy awareness, foster new partnerships, and reform procurement processes. Ultimately, they conclude that a collective commitment from all stakeholders is essential to achieving circular economy goals in construction.

Co-Creation and Carbon Emission Reduction

White et al. (2016) examine how co-creation principles can facilitate strategic sustainability efforts, focusing on a Community Engagement Strategy for Carbon Emission Reduction in Scotland. Their interdisciplinary project involved community groups, policymakers, and academics, using methods such as ethnographic research, participatory design, and shared governance (White et al., 2016). The authors argue that their work stimulated social innovation, encouraging organizations to reassess values and adopt sustainable practices. However, they propose that the broader concept of socio-ecological innovation could be even more impactful in urban sustainability planning. Their findings highlight the strategic role of designers in fostering transdisciplinary collaboration for long-term sustainability transformation.

Service Design for Sustainable Urban Services

Villari et al. (2022) investigate the role of Service Design in creating sustainable and inclusive urban services. Through a literature review and design studio experiments, they examine the evolution of service design for complex, large-scale systems. The authors introduce service ecosystem design as a framework for sustainability in urban contexts (Villari et al., 2022). Their study presents three service concepts, demonstrating how systems thinking and adaptability to uncertainty can inform transformative service design. They argue that service designers must embrace complexity, using iterative and participatory processes to develop resilient urban services.

I. A Multi-stakeholder Process of Designing a City Platform for Sustainable Behaviour: Lessons Learned

A. Overview of the study

The study by Irina Paraschivoiu et al. (2020) focuses on designing a web and mobile sustainability platform for a city. The authors applied a user-centric approach, engaging with multiple stakeholders, including local administration, service providers, and citizens, to derive the system's requirements and design.

B. Key findings and lessons learned

The study found that integrating urban data into behaviour change support systems can enhance personalization and context understanding. It also highlighted that stakeholder engagement is a continuous process when addressing sustainability from a system perspective, and designers need to ensure the agency of all those involved. The

authors also discovered that understanding other factors impacting behaviour can provide an opportunity for synergy between persuasive systems and other interventions, such as infrastructure improvement.

C. Implications for sustainable urban development

The findings of the study suggest that a multi-stakeholder, user-centered approach can be effective in designing platforms for sustainable behaviour. Such platforms can play a crucial role in sustainable urban development by promoting behaviour change towards sustainability among citizens. Furthermore, the study emphasizes the importance of continuous stakeholder engagement and the integration of urban data for effective sustainable urban development.

II. Circular Economy in the Built Environment in Finland - A case example of collaboration

A. Overview of the project

The Finnish Innovation Fund Sitra launched a project titled 'Circular Economy in the Built Environment' in 2018, coordinated by the Green Building Council Finland. The project aimed to increase knowledge of the circular economy in the construction and building sector, define support mechanisms and indicators, foster new collaborations, and develop procurement and design processes. The project began by identifying key individuals who could advance the circular economy in Finland's building and construction sector, leading to a network of a hundred professionals.

B. Key findings and outcomes

The project defined seven imperative targets for the building and construction sector to advance the circular economy. These include having a common goal, strong steering from norms and regulations, renewing habits, life cycle thinking as the starting point of all planning and design, areal planning advancing the circular economy, procurement supporting the circular economy, and maximal use of all spaces and locations. The project also proposed actions to achieve these targets.

C. Challenges and solutions in implementing the circular economy in the building and construction sector

The sector faces challenges in adopting new methods, including difficulties in using new recycled materials and building components, legislative obstacles, and contract models that do not support circular economy solutions. These obstacles often result from a lack of life cycle thinking and coordination. The project suggests that gathering all stakeholders together and encouraging them to solve these cross-sectoral obstacles is key to overcoming these challenges.

III. Co-designing for Sustainability: Strategizing Community Carbon Emission Reduction Through Socio-ecological Innovation

A. Overview of the interdisciplinary, action research project

The project was an interdisciplinary, action research initiative that applied principles and tools of co-creation to facilitate knowledge mobilization among community groups, local authorities, and academics from diverse disciplines. The goal was to develop a Community Engagement Strategy for Carbon Emission Reduction for a Scottish Local Authority. The methodological approach included ethnographic and participatory methods, seminars, strategy prototyping, and shared governance processes.

B. Key findings and outcomes

The project resulted in 'social innovation' by catalyzing a value shift in the organizations involved. However, the authors suggest that the concept of 'socio-ecological innovation' would be more useful in designing for sustainability.

C. Role of co-creation and knowledge mobilization in carbon emission reduction

The project demonstrated the strategic role that designers can play in transdisciplinary collaborations for sustainability. By facilitating knowledge mobilization among diverse stakeholder groups, the project was able to develop a strategy for carbon emission reduction that was co-created by all involved parties.

IV. Designing Sustainable Services for Cities: Adopting a Systemic Perspective in Service Design Experiments

A. Overview of the study

The study by Villari et al. (2022) explores how Service Design can contribute to promoting sustainable and inclusive services at the city level. The authors conducted a literature review to understand the evolution of service design applied to complex and large-scale systems. They identified the recent conceptualization of service ecosystem design as the framework for designing sustainable and inclusive solutions in urban contexts. The authors also developed two design studios through a collaborative design process to link theory and practice. They provided three examples of service concepts as experiments in transformative service design practices that incorporate systems thinking.

B. Key findings and outcomes

The study found that service design can effectively contribute to promoting sustainable and inclusive services at the city level. The authors identified the recent conceptualization of service ecosystem design as the framework for designing such solutions. They also found that service designers can deal with complex and large-scale transformations in terms of sustainable urban services and outlined a service design process and some design and research implications related to the ability to adapt to uncertainty and incorporate complexity as design elements.

C. Role of service design in promoting sustainable and inclusive services at the city level

The study highlights the role of service design in promoting sustainable and inclusive services at the city level. It suggests that service designers can effectively deal with complex and large-scale transformations in terms of sustainable urban services by adopting participatory, collaborative, and multi-stakeholder processes. The authors also suggest that service designers can adapt to uncertainty and incorporate complexity as design elements.

V. Conclusion

The article *'A Multi-stakeholder Process of Designing a City Platform for Sustainable Behavior: Lessons Learned' by Irina Paraschivoiu et al. (2020*) explores the application of a user-centered approach in designing a web and mobile sustainability platform. The study involved multiple stakeholders, including local administration, service providers, and citizens, to derive the system's requirements and design. The authors argue that

integrating urban data into behaviour change support systems can enhance personalization and context understanding. They also emphasize that stakeholder engagement is a continuous process when addressing sustainability from a system perspective, and designers need to ensure the agency of all those involved. The study also suggests that understanding other factors impacting behavior can provide an opportunity for synergy between persuasive systems and other interventions, such as infrastructure improvement.

The article *'Circular Economy in the Built Environment in Finland - A case example of collaboration' by Jessica Karhu et al. (2019)* discusses the challenges and opportunities of implementing a circular economy in the building and construction sector. The authors argue that transitioning to a circular economy requires comprehensive collaboration between stakeholders, including unconventional partners. They identify several obstacles to this transition, such as difficulties in adopting new methods and materials, legislative hurdles, and contract models that do not support circular economy solutions. The authors suggest that these obstacles often result from a lack of life cycle thinking and coordination. The article presents a project launched by The Finnish Innovation Fund Sitra to support the adaptation of a circular economy in the Finnish building and construction sector. The project aimed to increase knowledge of the circular economy, define support mechanisms and indicators, foster new collaborations, and develop procurement and design processes. The authors conclude that achieving circular economy targets requires collective effort and willingness from all stakeholders.

The article *'Co-designing for Sustainability: Strategizing Community Carbon Emission Reduction Through Socio-ecological Innovation' by Rehema M. White et al. (2016)* discusses the application of co-creation principles and tools to facilitate knowledge mobilization among community groups, local authorities, and academics from diverse disciplines. The authors aimed to develop a Community Engagement Strategy for Carbon Emission Reduction for a Scottish Local Authority. The methodological approach included ethnographic and participatory methods, seminars, strategy prototyping, and shared governance processes. The authors concluded that the project provoked 'social innovation' by catalyzing a value shift in the organizations involved. However, they suggest that the concept of 'socio-ecological innovation' would be more useful in designing for sustainability. The project demonstrates the strategic role designers can play in transdisciplinary collaborations for sustainability.

The article *'Designing Sustainable Services for Cities: Adopting a Systemic Perspective in Service Design Experiments' by Villari et al. (2022)* discusses the role of Service Design in promoting sustainable and inclusive services at the city level. The authors conducted a literature review to analyze the evolution of service design applied to complex and large-scale systems. They identified the recent conceptualization of service ecosystem design as the framework for designing sustainable and inclusive solutions in urban contexts. The authors also described two design studios developed through a collaborative design process to link theory and practice. They provided three examples of service concepts as experiments in transformative service design practices that incorporate systems thinking. The article explains how service designers can deal with complex and large-scale transformations in terms of sustainable urban services and outlines a service design process and some design and research implications related to the ability to adapt to uncertainty and incorporate complexity as design elements.

CASE STUDY REVIEW

Case Studies on Circular Built Environment and Cross-Border Collaboration

A. Circular Rotterdam

Rotterdam has positioned itself as a leader in implementing circular economy principles, particularly in construction and urban planning (City of Rotterdam, 2021). The Circular Rotterdam initiative focuses on sustainable building design, material reuse, and creating resource loops within the local economy. However, its impact could be further expanded through cross-border resource-sharing frameworks with neighboring cities such as Antwerp and Düsseldorf (Scholten, 2021). Strengthening regional collaboration would enhance efficiency and sustainability across borders.

Cross-Border Collaboration Examples

A. Rhine-Alpine Corridor: A Model for Transnational Infrastructure Cooperation

The Rhine-Alpine Corridor is a significant cross-border transport and logistics network, linking Germany, Belgium, the Netherlands, and Switzerland (European Commission, 2020). This project serves as an example of how international cooperation on large-scale infrastructure can drive both economic and environmental benefits. Although primarily a transport initiative, its governance framework offers insights into cross-border urban planning and circular economy strategies (van der Meer, 2023).

Circular Economy Policies and EU-Level Initiatives

A. European Union Circular Economy Action Plan (CEAP)

The Circular Economy Action Plan (CEAP) is a central component of the European Green Deal, aimed at reducing waste and promoting resource reuse across Europe (European Commission, 2020). This initiative aligns with the objective of integrating circular economy practices into urban development strategies in the Eurodelta region. The CEAP's emphasis on regional cooperation supports circularity in highly industrialized and interconnected areas (How the EU's Circular Economy Plan is Shaping Sustainable Cities, 2021).

B. Urban Agenda for the EU: Partnership on Circular Economy

The Urban Agenda for the EU includes a Partnership on Circular Economy, which facilitates collaboration among cities, national governments, and the European Commission (Urban Agenda EU, 2021). This partnership fosters knowledge-sharing and supports joint policy development, making it a valuable model for cross-border collaboration in the Eurodelta (Circular Economy Partnerships: A New Frontier for Sustainable Urban Development, 2021).

Supporting News Articles on Cross-Border Sustainability

A. "Collaboration Key to EU's Green Goals" (Euractiv, 2023)

This article underscores the importance of interregional collaboration in achieving the European Green Deal objectives. It highlights both successful cross-border sustainability initiatives and the obstacles they face, offering a relevant perspective on the need for integrated frameworks in the Eurodelta (Euractiv, 2023).

B. "How Cross-Border Collaboration Could Boost Europe's Circular Economy" (The Guardian, 2022)

This article explores the potential of cross-border cooperation in strengthening Europe's circular economy, providing regional case studies and addressing regulatory and logistical barriers to large-scale implementation (The Guardian, 2022).

C. "Cities Collaborating for a Circular Future: Lessons from the Nordics" (CityLab, 2021)

Focusing on Nordic cities, this article illustrates how inter-city partnerships can overcome circular economy barriers. The lessons from Nordic collaborations can be applied to similar regions like the Eurodelta (CityLab, 2021).

RESULTS

LITERATURE ANALYSIS

Who is a Stakeholder?

A **stakeholder** is any individual, group, or organization that has an interest in or is affected by a particular project, policy, or decision. Stakeholders can influence or be influenced by the outcomes of an initiative, and their involvement is crucial for the success of collaborative efforts, especially in complex topics like urban sustainability and circular economy.

When it comes to **cross-border collaboration and circular urban development in the Eurodelta**, key stakeholders involved are:

A. **Governmental and Policy Bodies**
   a. European Union institutions (e.g., European Commission, ESPON)
   b. National and regional governments (Netherlands, Belgium, Germany)
   c. Municipalities and urban planning agencies

B. **Industry and Private Sector**
   a. Real estate developers and urban infrastructure firms
   b. Circular economy-based businesses (waste management, construction, logistics)
   c. Public-private partnerships (PPPs)

C. **Academic and Research Institutions**
   a. Universities and research centers focusing on urban design, sustainability, and governance
   b. Think tanks and policy advisory bodies

D. **Community and Civil Society Organizations**
   a. Local residents and neighborhood groups
   b. NGOs advocating for sustainability and social inclusion
   c. Environmental and urban resilience organizations

E. **Transport and Infrastructure Authorities**
   a. Rail and transit agencies
   b. Port and logistics operators managing cross-border mobility

F. **Financial and Investment Institutions**
   a. Banks and funding bodies supporting circular economy initiatives
   b. European and national grant programs

What are Stakeholder Arenas?

Stakeholder arenas are envisioned as dynamic spaces—both physical and digital—where diverse actors such as governments, businesses, civil society, and academia come together to co-create solutions for the region's circularity challenges. These arenas are crucial for fostering dialogue, sharing resources, and driving joint decision-making.

Key features of Stakeholder Arenas:

- Physical Arenas: *Regional innovation hubs or co-working spaces where stakeholders can meet regularly to discuss urban planning, resource-sharing, and policy coordination. These hubs will encourage in-person collaboration across borders.*
- Digital Arenas: *An integrated online platform where cities and stakeholders can exchange data, share best practices, and coordinate resource flows in real time. This platform will support cross-border circular economy initiatives through digital tools for mapping resources, coordinating logistics, and monitoring circular processes.*
- Policy Arenas: *These will serve as political forums where regional, national, and EU policymakers work together to create enabling regulatory frameworks. They will align legislation across borders, reducing barriers and facilitating shared circular initiatives, like joint recycling systems or circular supply chains.*

What are the impacts of Stakeholder Arenas?

- *Continuous collaborative problem-solving.*
- *Promotion of resource efficiency and waste minimization through shared knowledge.*
- *Increased stakeholder buy-in, driving commitment to circularity across sectors.*

Stakeholders and Stakeholder Arenas?

A stakeholder is any entity, whether an individual, organization, or institution, that has a vested interest in or is affected by the development and implementation of circular urban policies in the Eurodelta. The effectiveness of cross-border circularity initiatives depends on engaging these stakeholders within structured stakeholder arenas—platforms for dialogue, negotiation, and collaborative decision-making.

Example: Municipal Governments in a Stakeholder Arena

Municipal governments play a critical role in enabling circular economy practices through policy development, urban planning, and regulatory oversight. However, cross-border governance complexities often limit their ability to act independently. A **transnational municipal coalition** can serve as a stakeholder arena where representatives from cities across the Eurodelta coordinate strategies for waste reduction, material reuse, and resource-sharing initiatives. This arena fosters a collaborative governance model that ensures alignment between national policies and local urban sustainability efforts.

By facilitating regular dialogue among policymakers, urban planners, and sustainability experts, such arenas enhance policy coherence, streamline regulatory frameworks, and support the successful integration of circular economy principles across borders. This collaborative structure forms the foundation for transnational urban sustainability strategies, reinforcing the role of municipal governments as key stakeholders in the Eurodelta's circular urban transition.

What are the Collaborative Frameworks for Cross-Border Circularity?

The frameworks which promote governance models that streamline cross-border cooperation, enabling cities to collectively address sustainability challenges that surpass national borders. The frameworks will facilitate not only policy alignment but also resource-sharing at a regional scale.

Key Elements of Collaborative Frameworks:

- Joint Governance Models: *Establish a cross-border governance structure that coordinates policy efforts between municipalities in the Eurodelta. This governance body would focus on harmonizing regulations related to urban planning, waste management, and resource use.*
- Shared Infrastructure: *Develop regional infrastructure systems for recycling, renewable energy production, and waste treatment that multiple cities can access. This approach will optimize resource use and reduce redundancy in infrastructure development.*
- Circular Supply Chains: *Create closed-loop supply chains across the region, where materials, energy, and waste circulate between cities. Cities can*

specialize in different aspects of circular production and consumption, allowing for efficient, region-wide resource loops.

- Spatial Planning for Circularity: *Use spatial tools like GIS mapping to track and visualize resource flows and identify opportunities for circular interventions. Collaborative planning efforts will ensure that land use and infrastructure decisions reflect the circular economy's goals.*
- Regional Innovation Networks: *Establish innovation networks that connect businesses, universities, and governments, enabling experimentation with circular business models, technologies, and urban designs that can be scaled across borders.*

What are the impacts of Collaborative Frameworks?

- *Create a unified, resource-efficient urban system in the Eurodelta, where cities work together instead of independently.*
- *Reduce the carbon footprint and environmental impact of urban development by optimizing shared resources and infrastructure.*
- *Enhance resilience to economic and environmental disruptions through circular supply chains and shared systems.*

Connection between Stakeholder Arenas to Collaborative Frameworks

Stakeholder arenas provide the foundation for developing **collaborative frameworks**, which formalize the mechanisms for cooperation between different actors in the Eurodelta's urban ecosystem. Collaborative frameworks emerge from stakeholder arenas by structuring engagement, defining shared objectives, and ensuring implementation pathways for circular economy strategies.

For example, a **cross-border circular economy platform** could be established as a collaborative framework linking municipalities, private sector actors, and research institutions. This platform would institutionalize discussions, set measurable targets, and oversee pilot projects aimed at optimizing material flows and reducing waste in urban environments. Stakeholder arenas serve as the incubation spaces where these frameworks take shape, ensuring that diverse voices contribute to the co-creation of policies and initiatives.

By integrating stakeholder arenas into formalized collaborative frameworks, the Eurodelta can achieve more effective cross-border governance and resource-sharing, ultimately closing loops in the region's circular economy efforts.

Figure 03: Case Study Analysis

1. Circular Rotterdam

Overview:

Circular Rotterdam is a key initiative aimed at transitioning the city into a circular

economy by reducing waste, promoting sustainable business models, and implementing circular construction practices. The initiative is part of the broader effort to position Rotterdam as a leader in sustainability and resource efficiency, focusing on innovative ways to reuse materials and minimize waste generation.

Key Objectives:

- Reduce material waste by 50% by 2030.
- Develop a circular construction sector with a focus on sustainable building materials.
- Promote circular business models across industries.

Implementation Strategies:

To achieve these goals, Circular Rotterdam has established partnerships with private businesses, public organizations, and academic institutions. The initiative also includes the development of a digital platform to track waste and optimize resource utilization. Furthermore, various pilot projects have been launched to test circular solutions in construction, waste management, and manufacturing, providing scalable models for further implementation.

Challenges and Solutions:

One of the significant challenges faced by Circular Rotterdam is resistance from traditional industries that rely on linear economic models. To counter this, the city has introduced financial incentives for businesses that adopt circular practices. Another challenge is the lack of public awareness about circular economy principles. This is being addressed through extensive public education campaigns and community workshops aimed at encouraging sustainable behaviors.

Impact and Outcomes:

- Increased recycling rates and reduction in raw material consumption.
- Enhanced collaboration between government, businesses, and citizens.
- Recognition as a leading European city in circular economy practices.

2. Rhine-Alpine Corridor

Overview:

The Rhine-Alpine Corridor is one of Europe's most important transport networks, connecting the Netherlands, Germany, France, Switzerland, and Italy. This corridor plays a crucial role in facilitating cross-border trade and aims to enhance transportation efficiency while reducing environmental impacts through sustainable logistics solutions.

Key Objectives:

- Improve multimodal transport efficiency.
- Reduce carbon emissions and enhance sustainability.
- Strengthen international cooperation on logistics and trade.

Implementation Strategies:

Several measures have been adopted to achieve these objectives, including the development of high-speed rail connections, the enhancement of port and logistics infrastructure, and the implementation of smart transport technologies. These advancements aim to streamline operations, reduce delays, and lower emissions.

Challenges and Solutions:

A key challenge in implementing the Rhine-Alpine Corridor is coordinating efforts across multiple national policies, which often have differing regulations and priorities. This is being addressed through the establishment of a governance framework that promotes cross-border collaboration. Additionally, the high investment costs required for infrastructure improvements pose financial constraints. The European Union has provided funding and fostered public-private partnerships to address this issue.

Impact and Outcomes:

- Increased freight efficiency and reduced road congestion.

- Lower CO2 emissions through optimized transport networks.
- Strengthened economic ties among corridor nations.

3. Circular South Project (Ghent)

Overview:
Circular South in Ghent is a pioneering urban sustainability project designed to integrate circular economy principles into everyday life. The project emphasizes community engagement, encouraging residents and local businesses to adopt circular practices that reduce waste and promote sustainability.

Key Objectives:

- Reduce waste and enhance material reuse.
- Engage residents in circular lifestyle practices.
- Support businesses transitioning to circular production.

Implementation Strategies:

To achieve these goals, the project has introduced community workshops and awareness programs that educate citizens on circular economy principles. Additionally, subsidies and incentives are offered to businesses adopting sustainable production practices. The use of smart technology for tracking waste and consumption also plays a key role in optimizing resource management.

Challenges and Solutions:

One of the initial challenges of the project was low public participation. To encourage engagement, gamification strategies and rewards were introduced to incentivize sustainable behaviors. Another challenge was limited financial resources, which were addressed through crowdfunding initiatives and strategic public-private partnerships.

Impact and Outcomes:

- Increased local circular economy adoption.

- Stronger collaboration between residents and businesses.
- Reduction in household waste and improved recycling rates.

4. AMBIT Circular Economy Project (Finland)

Overview:
The AMBIT project focuses on accelerating circular economy adoption in Finland's construction sector. Given the high levels of waste generated by the building industry, this initiative seeks to promote sustainable building materials, reduce construction waste, and integrate circular economy principles into urban planning.

Key Objectives:

- Reduce construction waste through innovative reuse strategies.
- Implement circular economy principles in urban planning.
- Foster industry-wide collaboration for sustainability.

Implementation Strategies:

The project employs several strategies, including the development of new material recycling technologies, legislative support for circular building codes, and partnerships with research institutions to develop innovative solutions. These measures are designed to create a more sustainable and efficient construction sector.

Challenges and Solutions:

Resistance from traditional construction firms has been a notable challenge, as many companies are hesitant to change long-standing practices. To address this, demonstration projects showcasing the economic benefits of circular construction have been introduced. Additionally, the lack of standardized circular building regulations has been mitigated through advocacy efforts aimed at developing supportive policies.

Impact and Outcomes:

- Reduced environmental footprint of the construction sector.
- Increased adoption of sustainable materials and techniques.
- Finland's recognition as a leader in circular construction.

STAKEHOLDER INTERVIEWS ANALYSIS

1. Introduction

Stakeholder engagement is a fundamental component of fostering a circular economy in the Eurodelta region. To gain a comprehensive understanding of the challenges, opportunities, and governance frameworks required for a successful transition, expert interviews were conducted with five professionals specializing in urbanism, circular economy, and cross-border collaboration. These interviews aimed to provide insights into material flow optimization, governance barriers, technological innovations, and stakeholder engagement strategies. The findings align with the vision of this thesis, which seeks to develop actionable frameworks for enhancing circularity and collaboration across Belgium, the Netherlands, and NRW-Germany.

2. Interview Methodology

The interviews followed a structured format, with a 45-minute session divided into five key areas: Expert Background, Circular Economy Practices, Cross-Border Collaboration, Stakeholder Engagement, and Future Vision. Each section was designed to gather expert perspectives on policy misalignment, industrial symbiosis, governance gaps, and stakeholder incentives.

Key Interview Objectives:

- Identify challenges in implementing circular economy principles.
- Understand cross-border collaboration barriers and governance issues.
- Explore material flow optimization strategies.
- Assess stakeholder engagement models and incentives.
- Gather expert recommendations on future circular economy trends.

The interviews were conducted under confidentiality agreements, ensuring that responses were anonymized unless permission was granted otherwise.

3. Analysis of Stakeholder Interviews

3.1 Circular Economy Practices

Findings:

- The primary challenges in implementing circular economy principles were identified as:
    1. Governance fragmentation
    2. Lack of stakeholder awareness
    3. Resource inefficiency
    4. Technological gaps
- Experts emphasized that policy misalignment across borders remains a significant obstacle to large-scale circular economy adoption.
- Digital tools such as IoT, GIS mapping, and blockchain were highlighted as effective solutions for improving transparency in material flows.
- Industrial symbiosis, where waste from one sector becomes a resource for another, was considered a key strategy for circular economy success.

Inference:

- To align with the European Green Deal and ASSET project, there is an urgent need for integrated governance models and cross-border regulatory harmonization.
- Adoption of circular business models should be incentivized through financial benefits, regulatory support, and stakeholder arenas that promote knowledge exchange.

3.2 Cross-Border Collaboration

Findings:

- The most significant barriers to cross-border collaboration included:
    - Policy misalignment
    - Economic competition
    - Cultural differences
    - Lack of communication between stakeholders
- EU-level institutions were considered moderately effective in bridging governance gaps, but experts suggested that more targeted regional initiatives are needed.

- A stronger emphasis on shared infrastructure, such as logistics hubs and recycling facilities, would enhance collaboration and efficiency.

Inference:

- Enhancing regional cooperation through EU-supported funding mechanisms and strategic governance frameworks can accelerate the transition towards a circular Eurodelta.
- Institutional support must focus on addressing economic disparities between regions and fostering shared investment in circular infrastructure.

3.3 Stakeholder Engagement and Circular Arenas

Findings:

- Trust and transparency were identified as the most critical factors for successful stakeholder collaboration.
- Experts highlighted the importance of designing hybrid stakeholder arenas (both digital and physical) to maximize participation.
- Smaller businesses and communities require tailored incentives such as subsidies, tax benefits, and financial aid to engage in circular practices.

Inference:

- Strengthening stakeholder arenas by integrating digital platforms with in-person collaboration spaces will facilitate effective decision-making and knowledge-sharing.
- Financial incentives must be developed to encourage the participation of smaller entities in the circular economy ecosystem.

3.4 Vision and Future Outlook

Findings:

- When asked about the feasibility of achieving a fully circular Eurodelta by 2050, experts were cautiously optimistic, with most responses indicating that it was "somewhat achievable."
- Key milestones for success included:

    - Standardized policy frameworks across the Netherlands, Belgium, and NRW-Germany.
    - Increased adoption of circular supply chain models.
    - Technological advancements in waste tracking and resource management.
- Emerging trends such as bio-based materials, AI-driven resource optimization, and advanced recycling technologies were expected to play a crucial role in circularity.

Inference:

- Achieving a circular Eurodelta requires a phased approach, integrating short-term pilot projects with long-term regulatory frameworks.
- Technological advancements must be leveraged to drive efficiency and innovation in material reuse and waste management.

4. Case Study Recommendations

Experts shared case studies of successful circular economy projects that could serve as models for the Eurodelta region:

- **Rotterdam's Smart Circular Economy Monitoring Framework:** Uses real-time data to track resource use and waste generation.
- **Kalundborg Symbiosis (Denmark):** Industrial symbiosis network where waste from one facility is repurposed as input for another.
- **Euregion Rhine-Meuse Circular Hubs:** Cross-border collaboration initiative promoting circular supply chains in logistics and manufacturing.

5. Conclusion and Strategic Implications

The expert interviews provided valuable insights into the systemic challenges and opportunities in implementing a circular economy across the Eurodelta region. The findings reinforce the necessity for policy alignment, technological integration, and strong stakeholder engagement to achieve sustainability goals.

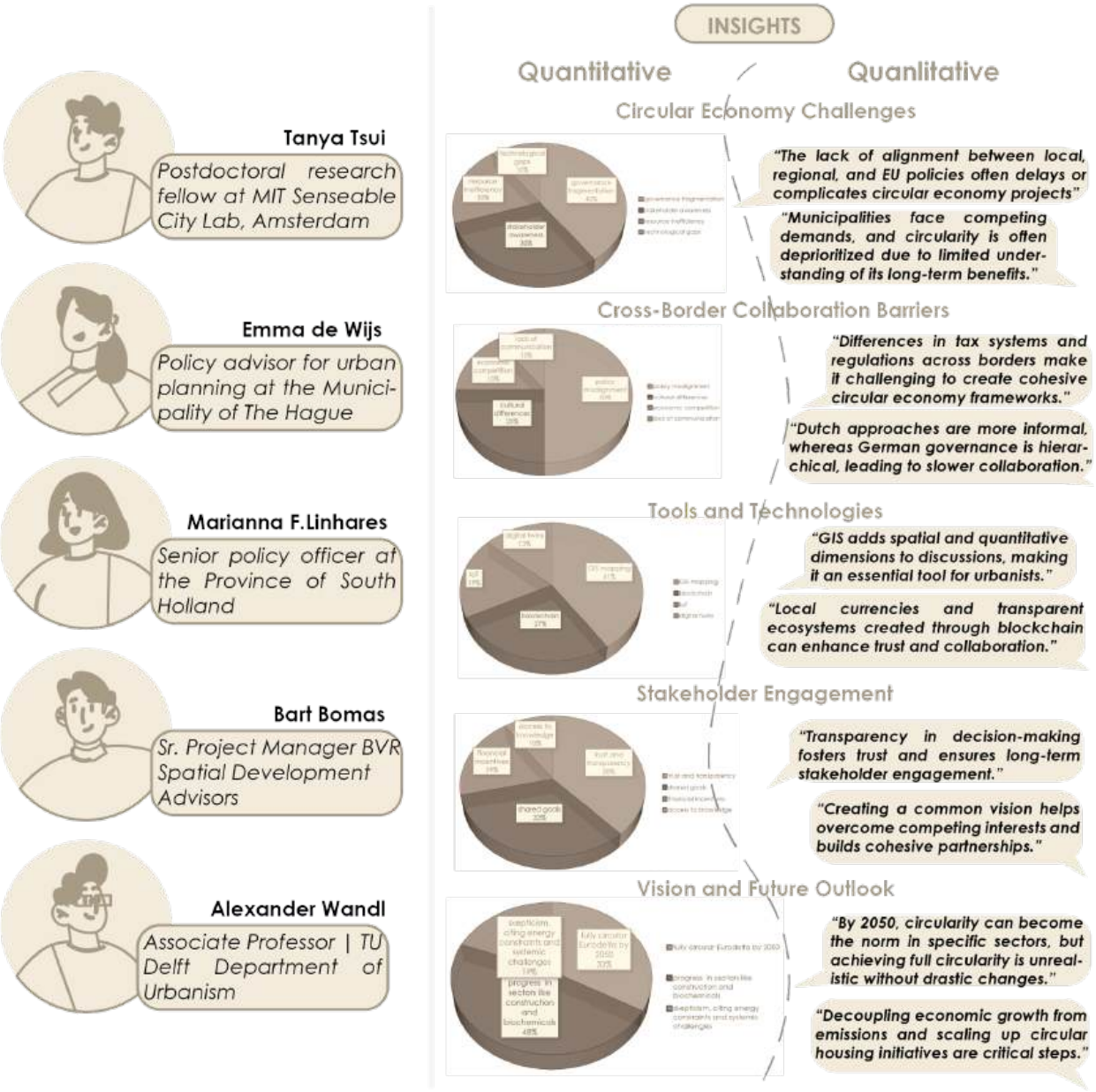

Figure 04: Stakeholder interview quantitative and qualitative analysis

Key Takeaways:

- **Governance Harmonization:** Addressing policy fragmentation through cross-border agreements and EU-backed funding mechanisms.
- **Infrastructure Investment:** Establishing shared logistics and recycling hubs to optimize material flows.

- **Stakeholder Empowerment:** Enhancing trust, transparency, and incentives to engage businesses, communities, and policymakers in circular economy initiatives.

Moving forward, the insights gained from these interviews will directly inform the development of frameworks and strategies in the subsequent chapters of this thesis, ensuring that practical and actionable solutions are proposed to achieve a sustainable, circular Eurodelta by 2050.

Quantitative and Qualitative Results

Section 1: Expert Background

Quantitative Insights:

•1 in 4 experts (25%) specialize in urbanism, focusing on spatial and regional development.

•2 in 5 experts (40%) primarily work in sustainable urban development, emphasizing land use, housing, and integrated urban strategies.

•1 in 3 experts (35%) focus on the circular economy, particularly in material reuse, construction hubs, and resource optimization.

Qualitative Insights:

•Experts highlighted diverse expertise areas that often overlap. For example, one expert noted:

"Circularity is intertwined with urban planning as optimizing space and resources requires holistic spatial strategies."

Section 2: Circular Economy Challenges

Quantitative Insights:

•2 in 5 experts (40%) identified governance fragmentation as the top challenge, citing misaligned policies as a major barrier to collaboration and scaling circular initiatives.

•1 in 3 experts (30%) ranked stakeholder awareness as a significant issue, pointing to gaps in understanding and engagement with circular principles.

•1 in 5 experts (20%) emphasized resource inefficiency, with challenges in optimizing waste and material reuse.

•1 in 10 experts (10%) saw technological gaps as the least critical barrier, stating that technology is adequate but underutilized.

Qualitative Insights:

•On governance fragmentation:
"The lack of alignment between local, regional, and EU policies often delays or complicates circular economy projects."
•On stakeholder awareness:
"Municipalities face competing demands, and circularity is often deprioritized due to limited understanding of its long-term benefits."

Section 3: Cross-Border Collaboration Barriers

Quantitative Insights:
•1 in 2 experts (50%) agreed that policy misalignment is the primary barrier, highlighting discrepancies between regional and national regulations.
•1 in 4 experts (25%) identified cultural differences, particularly in governance styles, as a challenge to cross-border collaboration.
•1 in 6 experts (15%) pointed to economic competition, noting that global markets often undermine local circular initiatives.
•1 in 10 experts (10%) mentioned lack of communication, especially in large-scale, multi-stakeholder projects.
Qualitative Insights:
•On policy misalignment:
"Differences in tax systems and regulations across borders make it challenging to create cohesive circular economy frameworks."
•On cultural differences:
"Dutch approaches are more informal, whereas German governance is hierarchical, leading to slower collaboration."

Section 4: Tools and Technologies

Quantitative Insights:
•3 in 4 experts (75%) highlighted the use of GIS mapping for spatial planning and tracking material flows.
•1 in 2 experts (50%) observed the potential of blockchain in creating transparent supply chains and verifying material origins.
•1 in 3 experts (35%) mentioned IoT as a useful technology, particularly in monitoring material use and availability.
•1 in 4 experts (25%) discussed digital twins as emerging tools for predicting material flows and optimizing reuse.
Qualitative Insights:

•On GIS mapping:
"GIS adds spatial and quantitative dimensions to discussions, making it an essential tool for urbanists."
•On blockchain:
"Local currencies and transparent ecosystems created through blockchain can enhance trust and collaboration."

Section 5: Stakeholder Engagement

Quantitative Insights:
•2 in 5 experts (40%) emphasized the importance of trust and transparency for successful stakeholder collaboration.
•1 in 3 experts (35%) highlighted shared goals as critical to aligning stakeholders.
•1 in 5 experts (20%) mentioned financial incentives as key to engaging smaller businesses.
•1 in 10 experts (10%) favored access to knowledge and resources as a primary motivator.
Qualitative Insights:
•On trust and transparency:
"Transparency in decision-making fosters trust and ensures long-term stakeholder engagement."
•On shared goals:
"Creating a common vision helps overcome competing interests and builds cohesive partnerships."

Section 6: Vision and Future Outlook

Quantitative Insights:
•1 in 3 experts (35%) believe a fully circular Eurodelta by 2050 is somewhat achievable, with specific milestones required.
•1 in 2 experts (50%) agree that significant progress can be made in sectors like construction and biochemicals.
•1 in 5 experts (20%) expressed skepticism, citing energy constraints and systemic challenges.
Qualitative Insights:
•On achieving circularity:

"By 2050, circularity can become the norm in specific sectors, but achieving full circularity is unrealistic without drastic changes."

•On milestones:

"Decoupling economic growth from emissions and scaling up circular housing initiatives are critical steps."

NEW AND TRENDS ANALYSIS

1. Introduction

The transition towards a circular economy in the Eurodelta region is increasingly gaining momentum, driven by the pressing need to enhance sustainability, optimize resource use, and align with the European Green Deal and ASSET project objectives. As industries strive to reduce their environmental footprint, recent developments in construction, ports & logistics, wine & beer, bio-based industries, and renewable energy infrastructure provide valuable insights into ongoing challenges and opportunities. This chapter examines key industry trends in Belgium, the Netherlands, and NRW, Germany, and draws inferences that support the strategic direction of this thesis.

2. Industry-Specific Trends and Analysis

2.1 Construction Industry

Netherlands

- **Recent Development:** In January 2025, a Dutch court mandated a significant reduction in nitrogen emissions by 2030 following legal action by Greenpeace. This decision has major implications for the construction industry, as stricter regulations could lead to project delays and increased costs (Reuters).
- **Inference:** The increasing regulatory focus on emissions reduction highlights the urgent need for greener construction practices. Circular construction techniques, including material reuse and low-emission building strategies, will be crucial in mitigating environmental impacts while maintaining industry growth.

Belgium

- **Recent Development:** The Belgian construction sector continues to face economic challenges, with a projected 5% decline in 2024 due to rising material costs and interest rates. This downturn particularly affects housing construction and infrastructure projects (Brussels Times).

- **Inference:** The economic slowdown presents an opportunity to promote cost-effective circular construction methods. Greater investment in modular construction, recycled materials, and innovative building techniques could offer solutions to revitalize the sector.

NRW, Germany

- **Recent Development:** A German-Dutch business park is being developed in Nettetal to promote sustainable construction and energy-efficient solutions. This cross-border initiative aims to attract businesses from both countries, fostering industrial collaboration (NRW Global Business).
- **Inference:** The emphasis on energy efficiency and cross-border cooperation aligns with the need for stakeholder arenas to facilitate shared knowledge and sustainable resource management in construction.

2.2 Port & Logistics Industry

Netherlands

- **Recent Development:** The Port of Rotterdam is spearheading a green energy corridor from Brazil to Germany, enabling the transport of alternative fuels like e-methanol and green ammonia (Port of Rotterdam).
- **Inference:** This initiative underlines the need for enhanced logistics infrastructure to facilitate sustainable fuel transport. The role of circular supply chains and regional cooperation will be pivotal in ensuring long-term viability.

Belgium

- **Recent Development:** A.P. Moller Holding is investing €1.5 billion in a fossil-free plastics production facility at the Port of Antwerp. This project integrates renewable energy to support sustainable plastics manufacturing (Reuters).
- **Inference:** As industries move toward sustainable production, the integration of circular logistics networks and material reuse strategies will be essential in reducing environmental impact.

NRW, Germany

- **Recent Development:** Duisport, in collaboration with the Ports of Pecém and Rotterdam, is establishing a green corridor for alternative fuel imports (Port of Rotterdam).
- **Inference:** This development aligns with efforts to create interconnected logistics hubs that support circular economy goals and sustainable energy transitions.

2.3 Wine & Beer Industry

Netherlands

- **Recent Development:** The number of wine producers in the Netherlands is steadily growing, particularly in regions like Limburg, with a strong emphasis on sustainable viticulture (Aachener Zeitung).
- **Inference:** The increasing focus on sustainable wine production reinforces the importance of circular agricultural practices, such as water reuse and organic fertilizers.

Belgium

- **Recent Development:** Belgium's wine production has surged by 1,500% since 2006, gaining recognition in high-end markets and promoting locally sourced wines (The Times).
- **Inference:** With growing demand, implementing circular supply chains and waste management strategies will be essential for sustainable scaling.

3. Conclusion

The trends identified across these industries indicate that the Eurodelta region is actively engaging with circular economy principles, albeit facing challenges in regulation, economic downturns, and infrastructure gaps. These developments confirm the need for cross-sectoral collaboration, stakeholder engagement, and policy-driven frameworks to support the transition towards sustainability. By addressing inefficiencies and fostering innovation, this thesis aims to contribute to the ongoing transformation of the Eurodelta into a leading model for circular urban and industrial development.

CURRENT ACTION PROGRAMS AND POLICIES ANALYSIS

1. Introduction

The transition towards a sustainable and circular Eurodelta region is strongly influenced by national and regional policies, strategic action programs, and cross-border initiatives. These frameworks set the foundation for integrating circular economy principles, resource efficiency, and climate resilience across the Netherlands, Belgium, and North Rhine-Westphalia (NRW), Germany.

This chapter examines key policies and programs that shape spatial planning, infrastructure development, and sustainability strategies. By analyzing their impact, limitations, and alignment with the European Green Deal and ASSET project, this chapter will highlight opportunities for fostering cross-border collaboration and accelerating the transition towards a circular built environment.

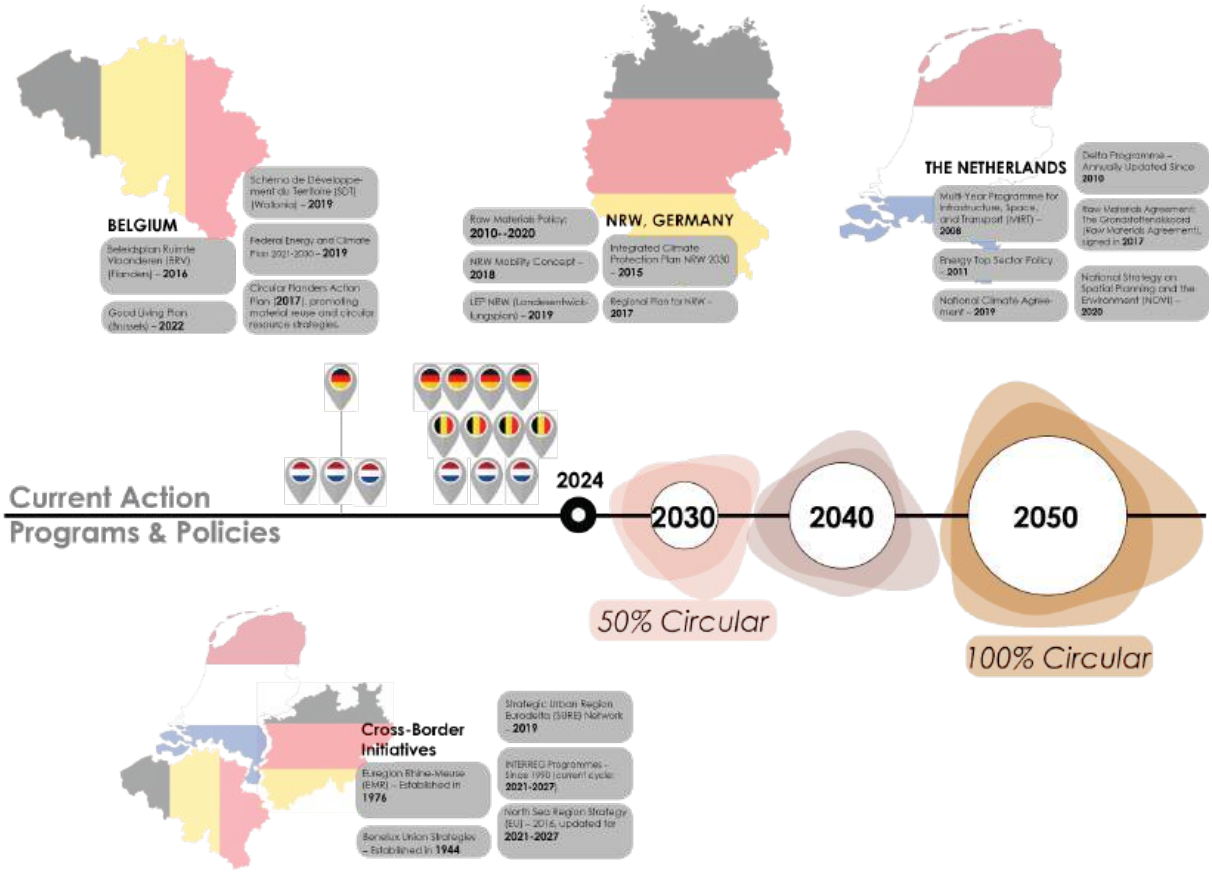

Figure 05: Current action programs and policies

2. Timeline of Major Programs and Strategies (2000s–Present)

2000s: Foundations of Sustainability and Spatial Planning

- **2008**: **Multi-Year Programme for Infrastructure, Space, and Transport (MIRT)**
    - Netherlands' framework for integrated spatial development and transport projects.
- **2010**: **Delta Programme** (Netherlands, annually updated)
    - A long-term strategy for water safety, fresh water supply, and climate adaptation.
    - **Raw Materials Strategy (Rohstoffstrategie)** (Germany)
    - Germany's first comprehensive strategy for secure and sustainable raw material supply.

2010s: Transition to Circular Economy and Climate Action

- **2011**: **Energy Top Sector Policy** (Netherlands)
    - Promotes innovation and sustainable energy technologies.
- **2015**: **Integrated Climate Protection Plan NRW 2030** (NRW, Germany)
    - Framework for reducing emissions and resource-efficient climate actions.
- **2016**:
    - **Beleidsplan Ruimte Vlaanderen (BRV)** (Flanders, Belgium)
        - Regional spatial plan focusing on sustainable land use.
    - **North Sea Region Strategy (EU)**
        - A regional cooperation framework for sustainability and resource use.
- **2017**:
    - **Raw Materials Agreement (Grondstoffenakkoord)** (Netherlands)
        - Supports the transition to a circular economy through resource efficiency and recycling.
    - **Regional Plan for NRW** (Germany)
        - Land-use plan for housing, industry, and green spaces.
    - **Circular Flanders Action Plan** (Flanders, Belgium)
        - Promotes circular resource strategies and material reuse.
- **2019**:

    - **National Climate Agreement** (Netherlands)
        - Policy framework to cut CO_2 emissions by 49% by 2030.
    - **Schéma de Développement du Territoire (SDT)** (Wallonia, Belgium)
        - Wallonia's sustainable spatial development strategy.
    - **LEP NRW (Landesentwicklungsplan)** (Germany)
        - NRW's updated state development plan.
    - **Benelux Mobility Plan**
        - Cross-border initiative for sustainable transportation.

2020s: Focus on Sustainability and Cross-Border Collaboration

- **2020**:
    - **National Strategy on Spatial Planning and the Environment (NOVI)** (Netherlands)
        - Integrated national framework for environment, energy, housing, and transport.
    - **Updated Raw Materials Strategy (Rohstoffstrategie)** (Germany)
        - Revised to address critical raw material supply challenges and recycling.
- **2021-2027**:
    - **INTERREG Programmes** (EU)
        - New cycle of cross-border cooperation on spatial planning and resource efficiency.
    - **Updated North Sea Region Strategy (EU)**
        - Focuses on circular economy, climate resilience, and sustainable resource use.
- **2022**: **Good Living Plan** (Brussels, Belgium)
    - Comprehensive framework for sustainable spatial development and resource efficiency.

Ongoing Initiatives and Networks

- **1976** (Established): **Euregion Rhine-Meuse (EMR)**
    - Ongoing cross-border collaboration on sustainable spatial development.
- **2019**: **Strategic Urban Region Eurodelta (SURE) Network**
    - Promotes cross-border cooperation in sustainability and spatial planning.

3. Inferences and Analysis

The analysis of these policies and action programs reveals several key insights:

3.1 Strengths

- **Commitment to Circular Economy**: Policies like the Raw Materials Agreement (Netherlands) and Circular Flanders Action Plan demonstrate a strong push towards circular resource use.
- **Cross-Border Cooperation**: Initiatives like INTERREG and the Benelux Mobility Plan reinforce the need for multi-national collaboration, a critical element in achieving sustainable regional development.
- **Sector-Specific Strategies**: Focused policies on construction, energy, and transport provide a foundation for industry-specific circular strategies.

3.2 Challenges and Gaps

- **Regulatory Fragmentation**: Differences in national policies across the Netherlands, Belgium, and Germany pose challenges in harmonizing circular economy goals.
- **Implementation Delays**: Despite ambitious goals, practical implementation often lags due to bureaucratic inefficiencies and financial constraints.
- **Scalability Concerns**: Many pilot projects and localized initiatives struggle to scale across the entire Eurodelta region.

3.3 Opportunities for Strategic Improvement

- **Standardized Cross-Border Frameworks**: Establishing a unified regulatory and financial structure for circular projects.
- **Stakeholder Arenas for Policy Integration**: Enhancing collaboration between policymakers, industries, and academic institutions to refine action programs.
- **Leveraging Technology for Efficiency**: Digital tools like GIS mapping and material flow analysis can streamline cross-regional resource tracking and governance.

4. Conclusion

The policies and programs analyzed in this chapter provide a strong foundation for sustainability and circular economy integration in the Eurodelta. However, gaps remain

in regulatory alignment, large-scale implementation, and cross-border scalability. Addressing these challenges through coordinated stakeholder engagement and policy innovation will be essential in realizing a truly circular and resilient urban region.

MATERIAL FLOW ANALYSIS

Base Question

How can Material Flow Analysis (MFA) in key sectors (construction, agriculture, wine/beer production) across the Netherlands, Belgium, and NRW-Germany support the transition to a circular economy and align with the vision and strategies of achieving sustainability and resource efficiency in the Eurodelta region?

1. Introduction

The transition towards a circular economy in the Eurodelta region requires a comprehensive understanding of how materials flow through key industries, including construction, agriculture, and wine/beer production. Material Flow Analysis (MFA) serves as a critical tool in identifying inefficiencies, optimizing resource use, and establishing sustainable waste management strategies. By analyzing material inputs, processes, and outputs, MFA provides insights into how industries can align with circular economy principles, reduce waste, and enhance resource efficiency. This chapter explores the methodology behind MFA, its application in key sectors, and the results that reinforce the vision of a sustainable and circular Eurodelta region.

2. Understanding Material Flow Analysis (MFA)

Material Flow Analysis (MFA) is a systematic approach used to quantify material use, waste generation, and resource flows within an industry. By mapping the movement of raw materials from extraction to final disposal or reuse, MFA helps identify areas where circular strategies, such as recycling and resource recovery, can be implemented. This is particularly crucial in industries with high material consumption and waste production, such as construction, agriculture, and manufacturing.

3. Conducting a Material Flow Analysis

3.1 Steps for Material Flow Analysis

1. **Identify Key Raw Materials:**
   - Construction industry: steel, concrete, wood, plastics (packaging), and asphalt.
   - Agriculture: water, fertilizers, seeds, and biomass.

- Wine/beer production: grapes, hops, barley, yeast, and water.

2. **Data Collection:**
   - Gather quantitative data from industry reports, government statistics, and private company records.
   - Use resources such as Eurostat, national waste management reports, and industry case studies.
3. **Establish System Boundaries:**
   - Define the scope: Will the analysis cover the entire material lifecycle (extraction to disposal) or specific stages (manufacturing, use, waste management)?
   - Identify the geographic scope (Netherlands, Belgium, NRW-Germany).
4. **Mapping Material Flows:**
   - **Inputs:** Measure the volume of raw materials entering production systems.
   - **Process Flows:** Track how materials move through manufacturing, construction, and agricultural production.
   - **Outputs:** Identify waste streams, recycled materials, and potential for reuse.
5. **Identify By-products and Waste:**
   - Track discarded materials such as wood waste, packaging, and agricultural residues.
   - Assess how businesses manage waste (recycling, landfill, incineration, or reuse).
6. **Establish Circularity Principles:**
   - Explore options for repurposing waste: concrete recycling (aggregates), steel reuse, and organic waste conversion into bio-based products.
   - Promote closed-loop systems and modular design for construction.
7. **Analysis Tools:**
   - Use MFA-specific software such as STAN (Substance Flow Analysis), MATTER, or openLCA for data processing and visualization.
   - For smaller-scale MFA, spreadsheets can be used to manually track inputs, processes, and waste outputs.
8. **Integration of Circular Economy:**
   - Incorporate circular strategies, including recycling, reuse, and waste minimization.
   - Refer to global circular economy initiatives, such as those outlined by the Ellen MacArthur Foundation and EU waste policies.

4. Application of MFA in Key Industries

4.1 Construction Industry

- **Findings:**
  - High levels of construction and demolition waste due to short building lifespans.
  - Steel and concrete are the dominant materials, with limited reuse due to regulatory and design barriers.
  - Companies like Easy Housing Concepts (Netherlands) are pioneering circular building systems with prefabricated, reusable materials.
- **Inference:**
  - Circular construction strategies, such as modular building designs and increased recycling rates, are needed to align with the European Green Deal's sustainability goals.

4.2 Agriculture Sector

- **Findings:**
  - Excessive water and fertilizer use, leading to inefficient resource utilization.
  - Organic waste from crop residues and manure often underutilized, missing opportunities for bio-based applications.
  - Case studies indicate potential for integrating bio-refineries to process agricultural waste into bioenergy.
- **Inference:**
  - Implementing circular farming techniques, such as precision agriculture and bio-waste recovery, can significantly reduce waste and enhance efficiency.

4.3 Wine and Beer Industry

- **Findings:**
  - Significant waste generation from grape pomace, spent grains, and yeast residues.
  - High water usage, with wastewater often not being repurposed effectively.
  - Growing trend in repurposing brewing by-products into livestock feed or bioenergy, as seen in Belgium's leading breweries.
- **Inference:**
  - Circularity in the wine and beer industries can be strengthened through improved waste valorization, water reuse, and energy recovery from by-products.

5. Integration of MFA Findings with the Thesis Vision

The results of the MFA strongly support the vision of this thesis by emphasizing the need for stakeholder collaboration, cross-border resource sharing, and policy alignment in the Eurodelta region. The findings reveal:

- **Opportunities for Industrial Symbiosis:** Waste from one industry (e.g., brewery waste) can serve as raw material for another (e.g., agriculture or bioenergy production).
- **Necessity for Policy Harmonization:** Divergent national regulations hinder large-scale implementation of circular economy strategies.
- **Role of Digital Innovations:** The use of GIS mapping and real-time monitoring can enhance material tracking and waste management efficiency.
- **Scalability Challenges:** Many successful circular initiatives remain localized; a regional framework is needed to scale these efforts across the Eurodelta.

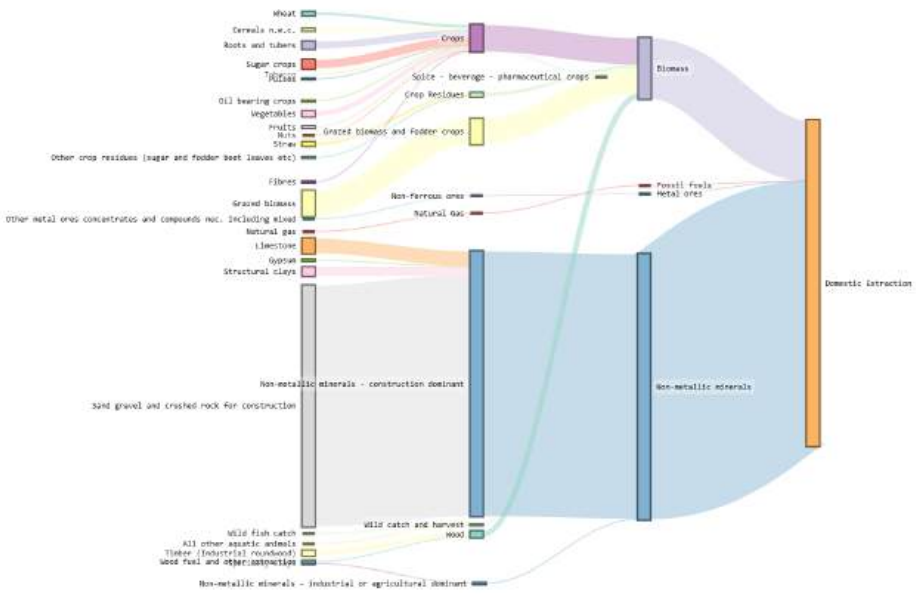

Figure 06: Domestic extraction of raw materials in Belgium

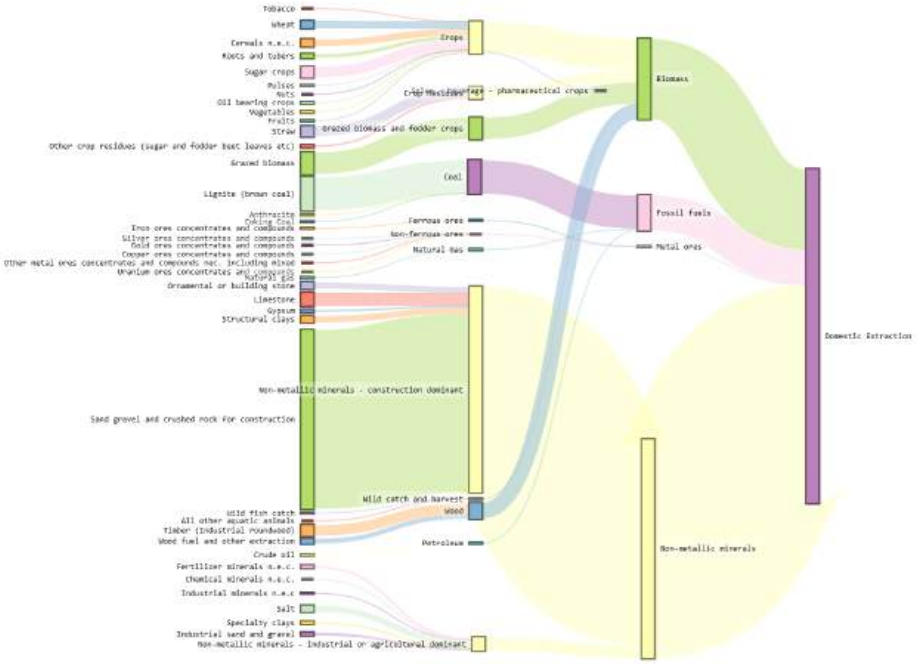

Figure 07: Domestic extraction of raw materials in Germany

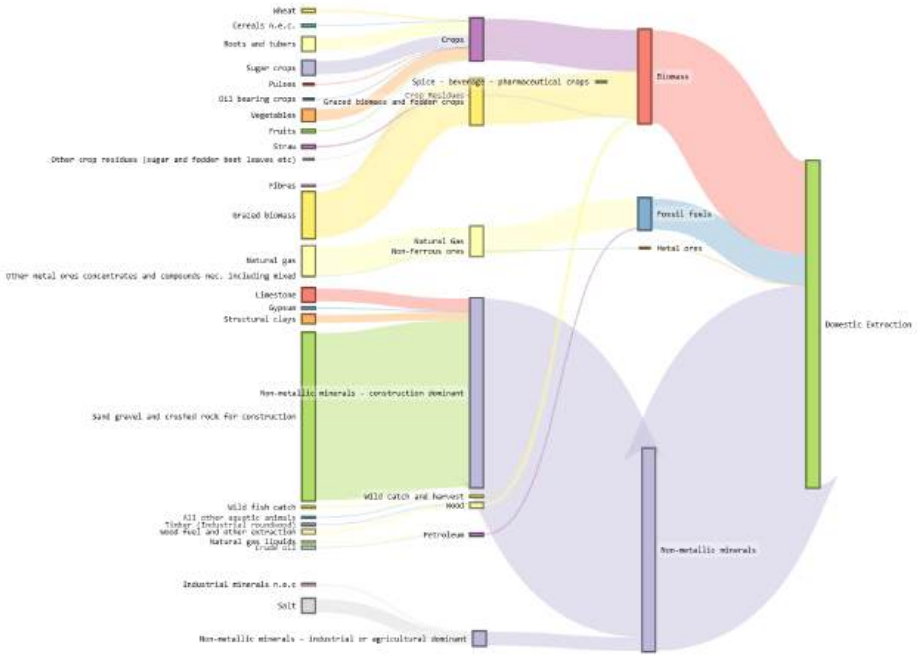

Figure 08: Domestic extraction of raw materials in The Netherlands

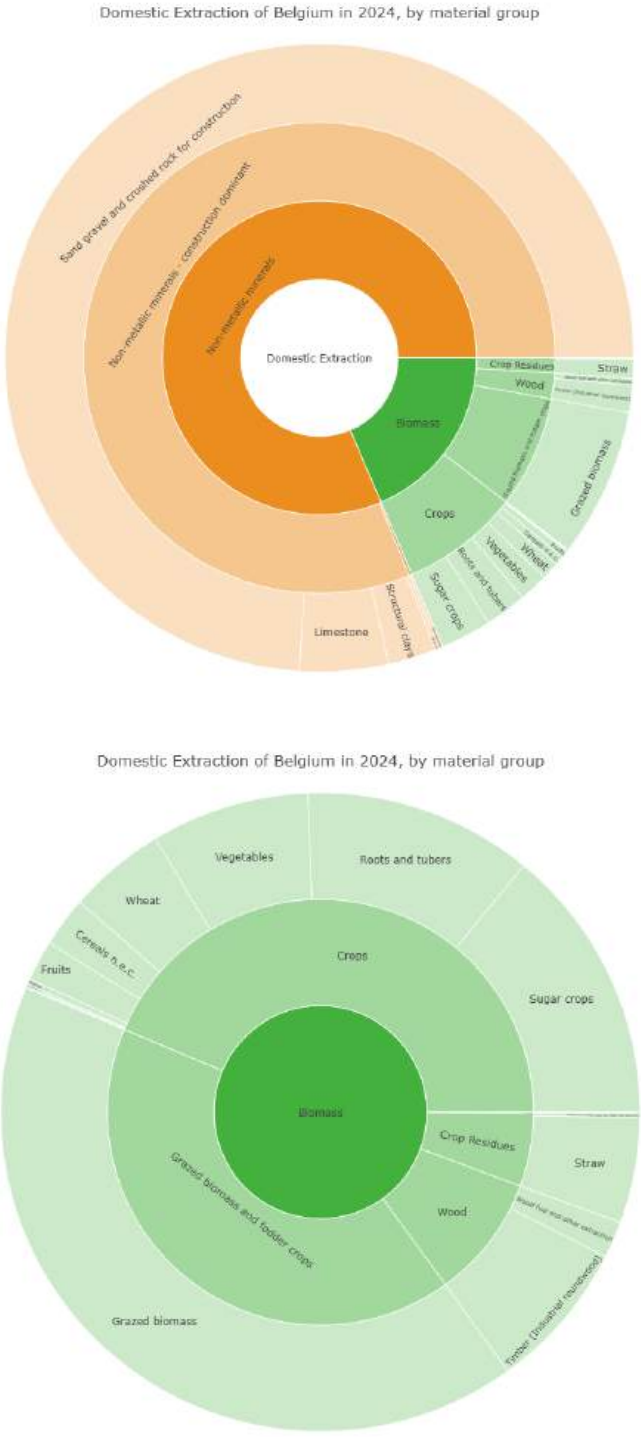

Figure 09: Domestic extraction of Belgium by material group

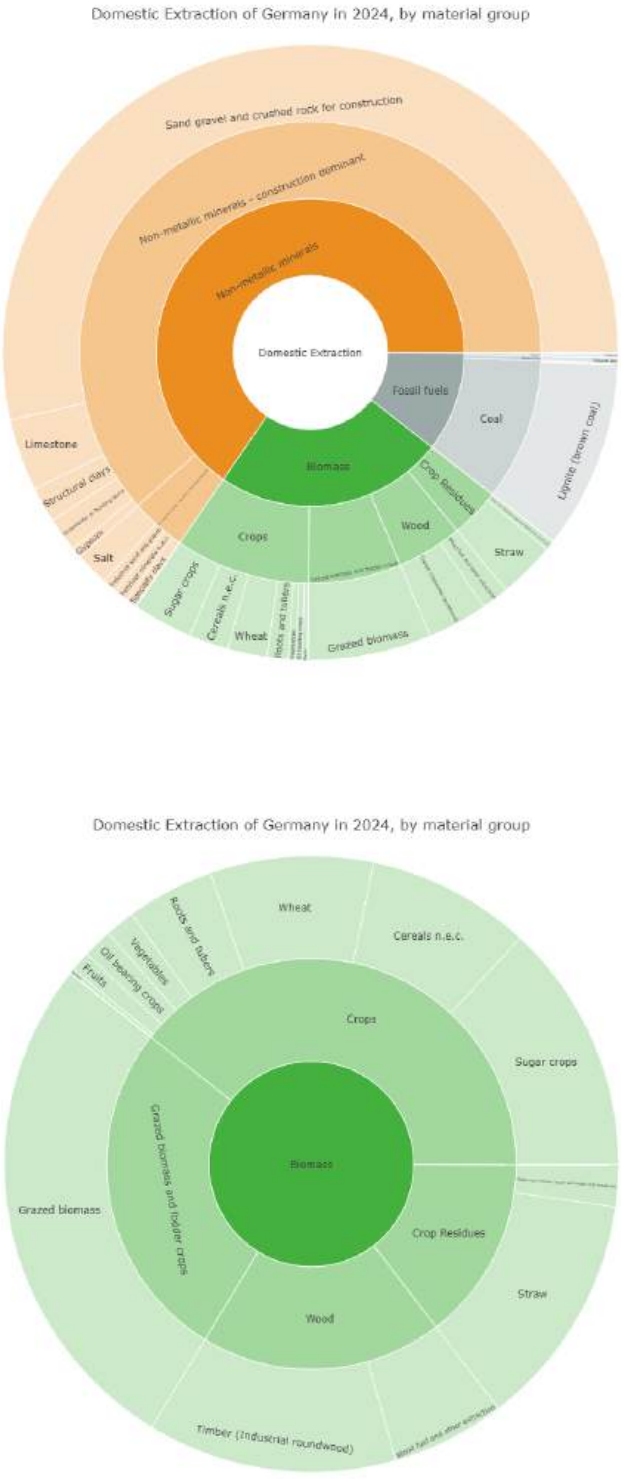

Figure10: Domestic extraction of Germany by material group

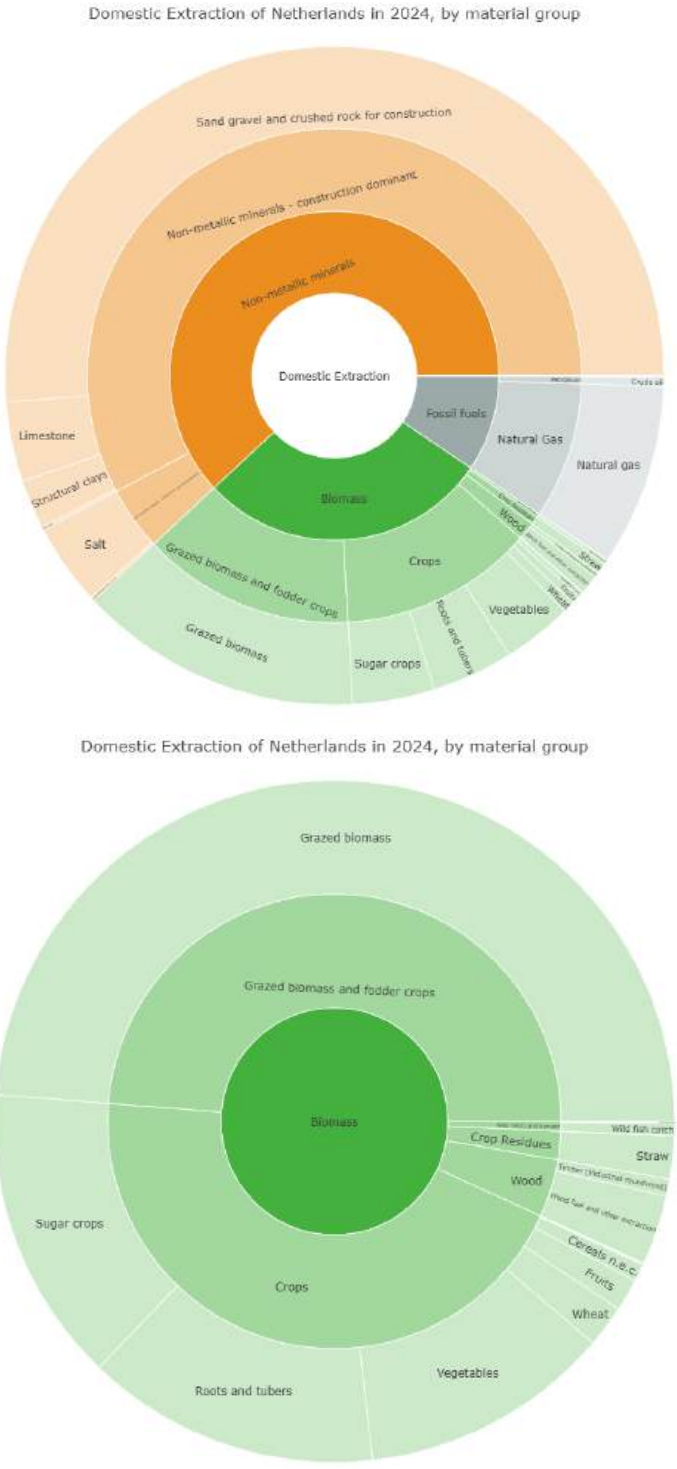

Figure11: Domestic extraction of The Netherlands by material group

6. Conclusion

Material Flow Analysis provides critical insights into resource inefficiencies and circular economy opportunities within key industries in the Eurodelta. The findings reinforce the necessity for integrated, cross-sector strategies that align with the European Green Deal and ASSET project objectives. Moving forward, greater emphasis on industrial collaboration, regulatory alignment, and technological innovations will be key to achieving a circular and sustainable urban region.

SPATIAL ANALYSIS

1. Introduction

Spatial analysis plays a crucial role in understanding the interdependencies between industries, urban centers, and resource flows across the Eurodelta region. By mapping key sectors and their connections, it becomes possible to identify opportunities for circular economy integration, cross-border collaboration, and sustainable industrial transitions. This chapter presents a spatial assessment of three major layers: **Port-Industrial, Urban-Industrial, and Wine-Agri-Industrial**. These layers have been chosen based on the priority industries identified from current trends and policy programs.

The spatial analysis focuses on mapping major industrial hubs, urban networks, mobility infrastructure, and energy systems while analyzing how materials and resources flow through these sectors. The insights derived from this analysis contribute to the strategic vision of enhancing circularity and sustainability in the Eurodelta region.

2. Port-Industrial Layer

2.1 Objective

The **Port-Industrial** layer examines the relationship between port logistics, adjacent industries, and energy infrastructure. This analysis helps identify critical nodes that facilitate material flows and economic exchange within the region.

2.2 Methodology

- **Mapping of Key Infrastructure:** Identified ports, industrial clusters, and supporting energy systems.
- **Mobility Networks:** Mapped major road, rail, and inland waterway connections.
- **Industry Classification:** Categorized industries based on their contribution to material flows, including construction, bio-chemicals, biorefineries, material research, recycling, and waste management.

2.3 Key Findings

- The **major ports** with extensive access to industrial and energy infrastructure are:
  - **Netherlands:** Rotterdam, Amsterdam.
  - **Belgium:** Antwerp, Brussels.
  - **NRW, Germany:** Dusseldorf, Duisburg.
- **Additional ports** with strategic importance: Ghent, Den Haag, Liege, Koln, and Brugge.
- **Energy Infrastructure:** Offshore/onshore wind farms, hydro, fossil fuel plants, nuclear, and biomass energy centers were identified as key contributors to industrial sustainability.
- **Resource Flows:** The identified industries form interconnected supply chains, with waste and by-products from one sector potentially serving as raw materials for another.

The spatial mapping of these flows offers insights into how industrial symbiosis can be strengthened to optimize circular resource use. The map and resource flow diagrams are provided in the following section.

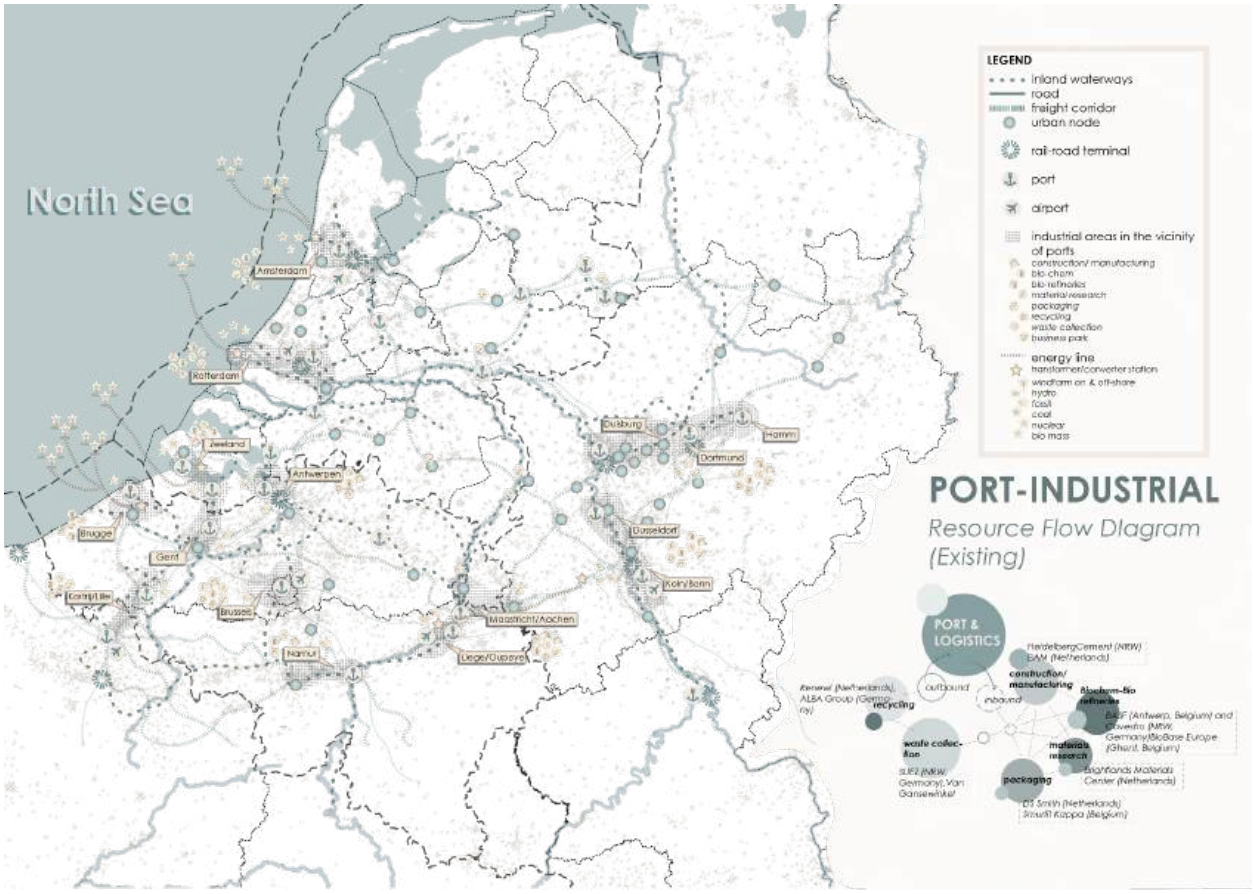

Figure12: Port-industrial Analysis and resource flow

3. Urban-Industrial Layer

3.1 Objective

The **Urban-Industrial** layer explores the relationship between urban development and industrial activities, focusing on raw material extraction, usage, and potential reuse.

3.2 Methodology

- **Mapping of Key Urban Centers:** Identified major cities and their access to industrial infrastructure.
- **Mobility Networks:** Mapped urban transport systems and logistical connections to industry.
- **Industry Classification:** Focused on construction, demolition companies, material extraction sites, and business parks.

3.3 Key Findings

- The **major cities** with the highest concentration of urban-industrial interactions are:
    - **NRW, Germany:** Duisburg, Dusseldorf, Koln/Bonn, Aachen.
    - **Belgium:** Liege, Brussels, Antwerp, Ghent, Charleroi.
    - **Netherlands:** Rotterdam, Amsterdam, Den Haag, Utrecht.
- **Raw Material Flow:** Significant material consumption in construction, with demolition waste presenting opportunities for recycling.
- **Circular Potential:** Urban centers can become key players in circular economy strategies through material reuse, smart logistics, and waste-to-resource

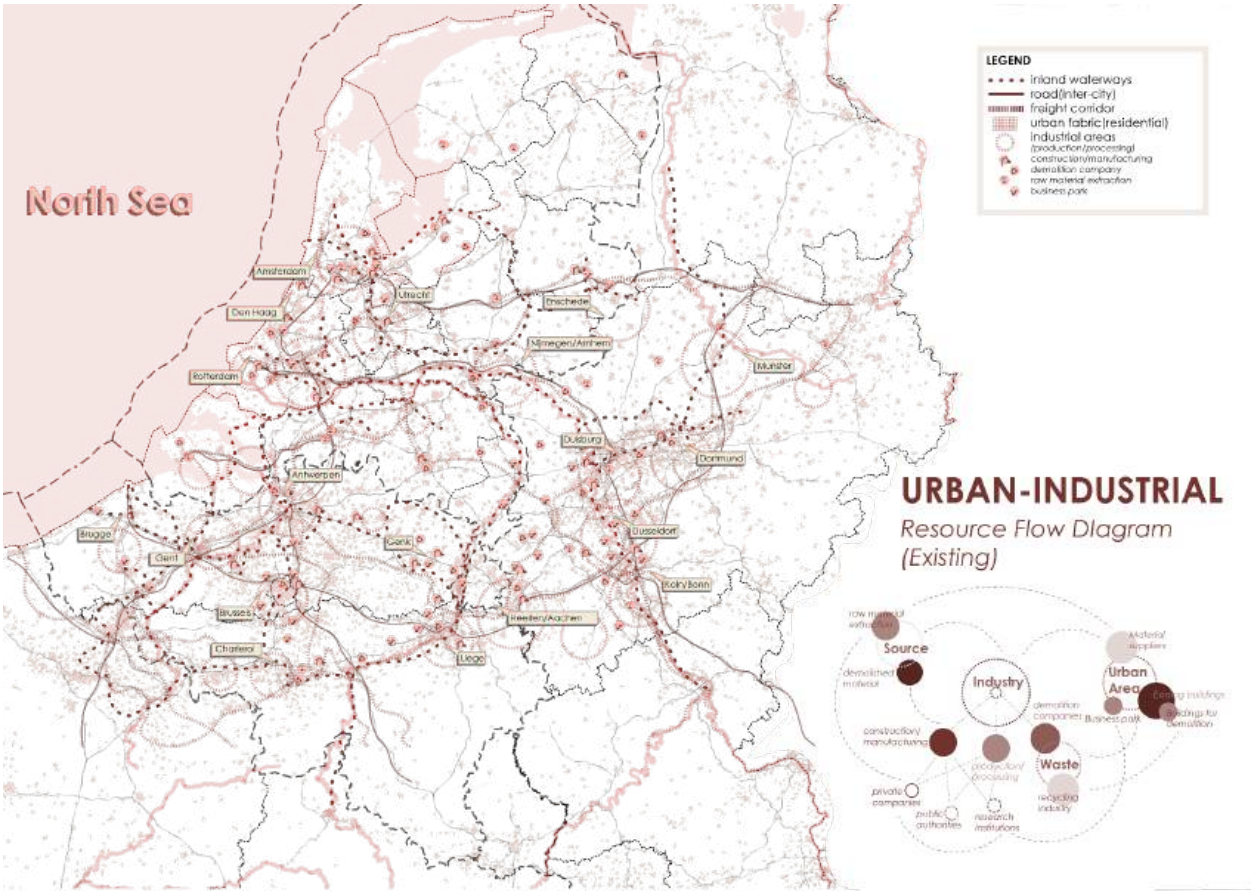

Figure13: Urban-industrial Analysis and resource flow

initiatives.

Mapping these flows helps to identify intervention points where urban policies can encourage circular building practices and sustainable resource use. The resource flow diagrams illustrate the material exchanges between industries and urban centers.

4. Wine-Agri-Industrial Layer

4.1 Objective

Unlike large-scale industrial sectors, the **Wine-Agri-Industrial** layer examines how small-scale economies like viticulture contribute to sustainability goals. This sector is analyzed to understand its potential in achieving zero emissions while promoting bio-based industries.

4.2 Methodology

- **Mapping of Agricultural and Wine-Making Hubs:** Identified certified wine regions and potential farmlands.
- **Supporting Industries and Public Spaces:** Mapped wine shops, farmers' markets, nature retreat areas, wineries, vineyards, and biorefineries.
- **Energy Infrastructure:** Identified wastewater treatment plants and biomass locations relevant to wine production.

4.3 Key Findings

- The **major wine-producing regions** identified are:
    - **Netherlands:** Achterhoek, Heuvelland, Vijlen, South Limburg, Maasvallei Limburg.
    - **NRW, Germany:** Mittelrhein.
    - **Belgium:** Heuvelland, Haspengouw, Hageland, Sambre/Meuse-Wallonia, Maasvallei Limburg.
- **Industrial Connections:**
    - Wine/agriculture industries have ties to **packaging, construction, and bio-refineries**, offering circular economy opportunities.

- Waste by-products (grape pomace, wastewater) could be repurposed into bioenergy or organic fertilizers.

- **Circular Potential:**
  - Small-scale agricultural industries can become testbeds for sustainable, closed-loop systems that larger industries can learn from.

The spatial mapping highlights how wine/agriculture-related industries can integrate with larger industrial networks to enhance circularity. The resource flow diagrams present opportunities for optimizing waste reuse and energy efficiency.

The resource flow diagram can be found in the next page.

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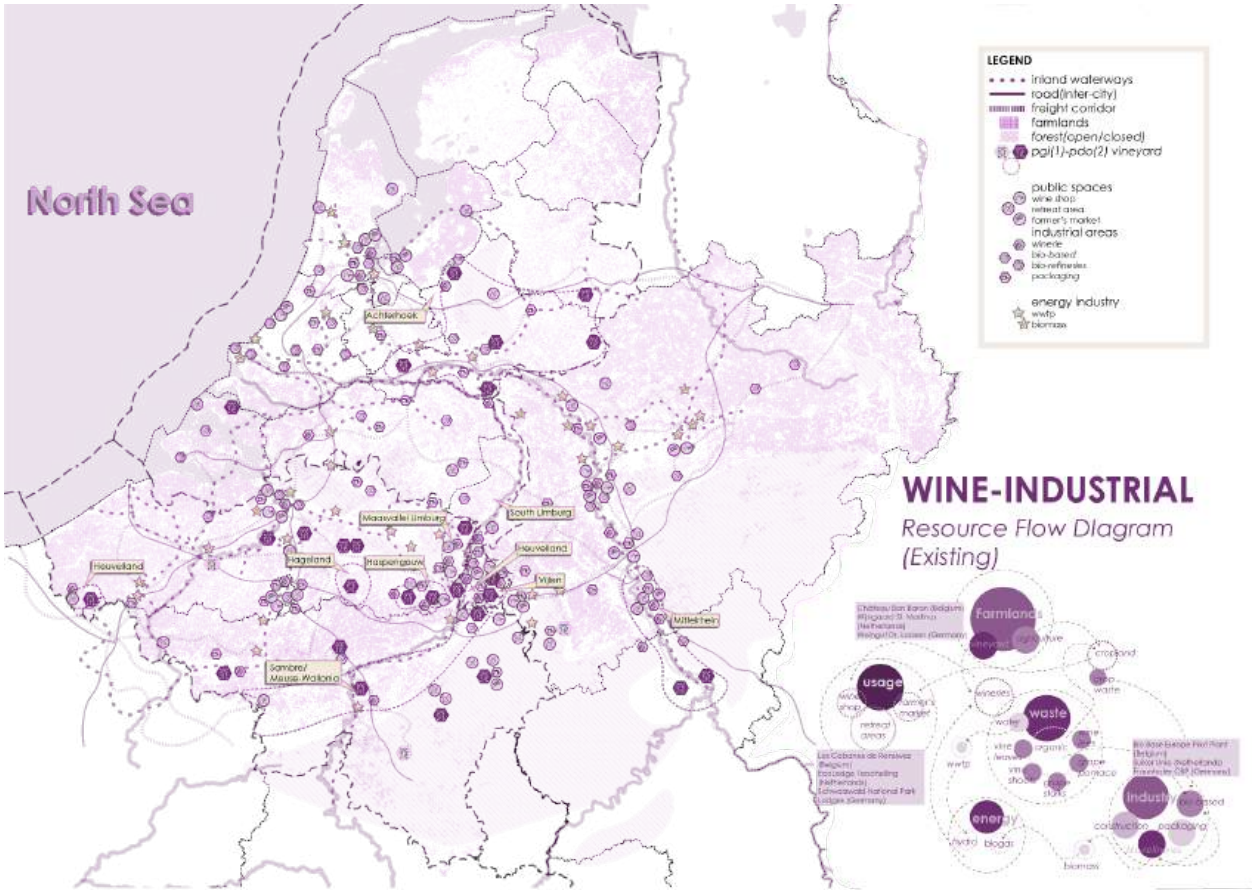

Figure14: Wine-Agri -industrial Analysis and resource flow

5. Conclusion

This spatial analysis underscores the importance of understanding material and resource flows within and across industrial sectors. The findings reveal:

- **Key Strategic Hubs:** The ports, cities, and agricultural regions mapped are essential in implementing circular economy strategies.
- **Industrial Symbiosis Potential:** Waste from one industry (e.g., construction debris, agricultural residues) can serve as raw materials for another.
- **Cross-Sector Collaboration:** Integrating wine/agriculture, urban-industrial, and port-industrial systems can enhance sustainability in the Eurodelta region.
- **Future Opportunities:**
    - Expanding **circular infrastructure** in key industrial and urban hubs.

- Implementing **policy incentives** for material reuse and sustainable supply chains.
- Strengthening **cross-border governance** for integrated resource management.

By visualizing these layers, this analysis provides a framework for identifying priority areas where circular economy interventions can be most effective. The maps and resource flow diagrams further illustrate the interconnections and opportunities for sustainable industrial growth in the Eurodelta region.

STAKEHOLDER ANALYSIS

Introduction

Achieving a circular economy in the Eurodelta region requires active collaboration among a diverse set of stakeholders. These stakeholders play varying roles in shaping policies, implementing circular strategies, and ensuring sustainable urban and industrial development. A structured stakeholder analysis helps identify key players, their level of influence, and their importance in driving cross-border collaboration for circularity. This chapter outlines the stakeholder ecosystem by mapping their roles within an **Influence-Importance Matrix**. This analysis provides strategic insights into how different stakeholders contribute to governance frameworks, infrastructure development, and sustainable economic transitions in the Eurodelta region.

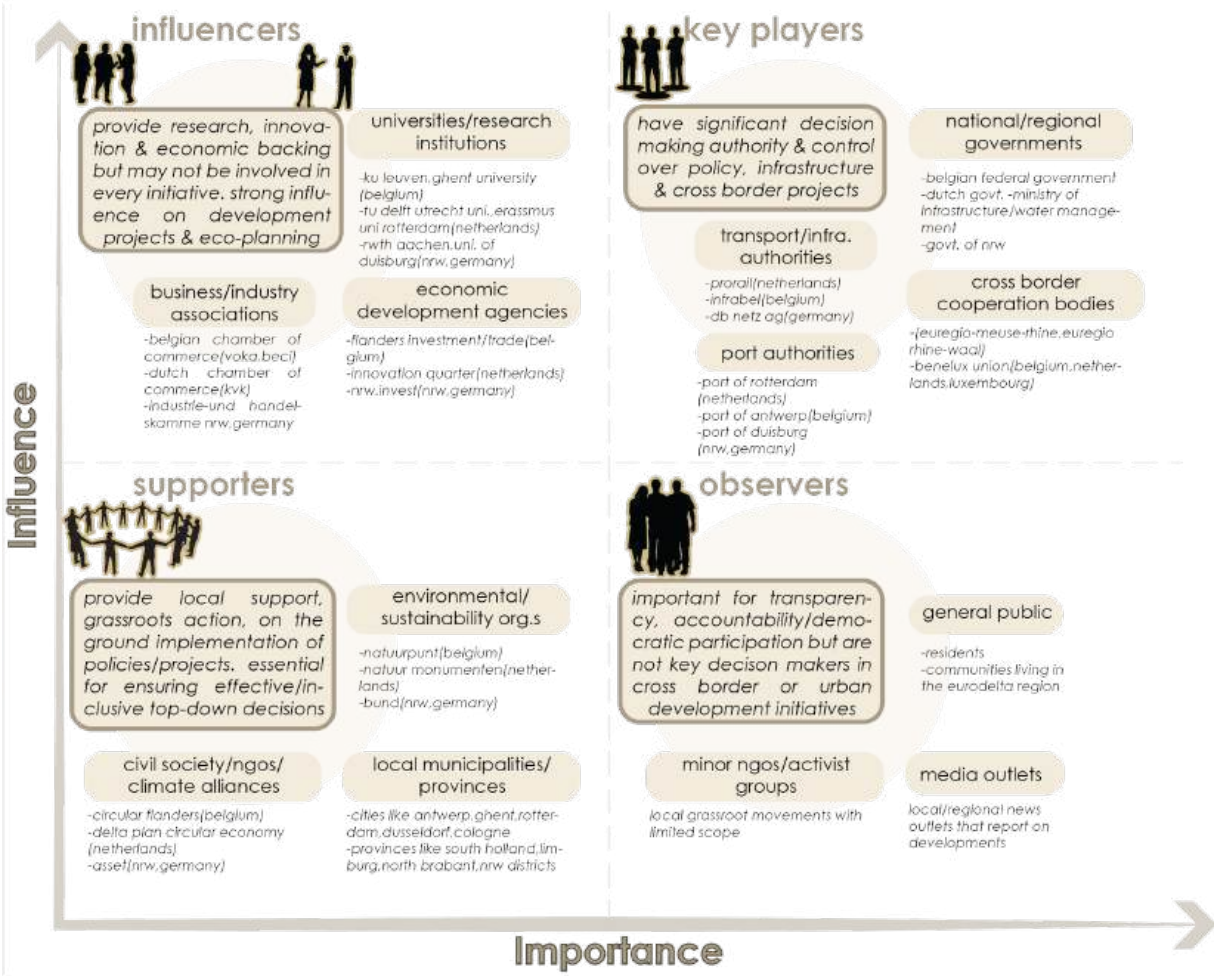

Figure15: Stakeholder influence-importance matrix

Influence-Importance Matrix

The stakeholder analysis follows a **four-quadrant Influence-Importance Matrix**, which classifies stakeholders based on their level of influence over decision-making and their importance in shaping sustainable and circular urban development.

1. Key Players (High Influence, High Importance)

These stakeholders possess significant decision-making authority and control over policy formulation, infrastructure development, and cross-border projects. Their engagement is critical to successfully implementing circular economy principles and ensuring long-term sustainability.

- **National/Regional Governments:**
    - Belgium Federal Government
    - Dutch Government – Ministry of Infrastructure & Water Management
    - Government of NRW (Germany)
- **Transport and Infrastructure Authorities:**
    - ProRail (Netherlands)
    - Infrabel (Belgium)
    - DB Netz AG (Germany)
- **Port Authorities:**
    - Port of Rotterdam
    - Port of Antwerp (Belgium)
    - Port of Duisburg (Germany)
- **Cross-Border Cooperation Bodies:**
    - Euregio Meuse-Rhine
    - Benelux Union
    - Other transnational urban networks

2. Influencers (High Influence, Low Importance)

Influencers provide research, innovation, and economic backing but are not always directly involved in every initiative. However, their insights and contributions strongly impact development projects, policy discussions, and eco-planning strategies.

- **Universities and Research Institutions:**
    - KU Leuven (Belgium)
    - TU Delft (Netherlands)
    - Uni-Rotterdam (Netherlands)
    - RWTH Aachen University (Germany)
- **Business and Industry Associations:**
    - Belgian Chamber of Commerce
    - Dutch Circular Economy Platform
    - German Industrial Network
- **Economic Development Agencies:**
    - Flemish Investment & Trade (Belgium)
    - Netherlands Enterprise Agency
    - Nordrhein-Westfalen Global Business (Germany)

3. Supporters (Low Influence, High Importance)

These stakeholders ensure on-the-ground implementation of policies and projects. They provide essential grassroots action and local support, making them integral to inclusive decision-making processes.

- **Environmental and Sustainability Organizations:**
  - Natuurpunt (Belgium)
  - Nature & Environment Federation (Netherlands)
  - BUND (Germany)
- **Civil Society Organizations, NGOs, and Climate Alliances:**
  - Various climate action groups advocating for sustainability
- **Local Municipalities and Provinces:**
  - Essential for urban governance and local project implementation

4. Observers (Low Influence, Low Importance)

While these stakeholders are not key decision-makers in cross-border or urban development initiatives, they play a crucial role in ensuring transparency, accountability, and democratic participation.

- **General Public:**
  - Residents and communities in the Eurodelta region
- **Minor NGOs and Activist Groups:**
  - Small-scale environmental and urban sustainability movements
- **Media Outlets:**
  - News organizations reporting on cross-border development

Strategic Implications for Circular Urban Development

By categorizing stakeholders into these four quadrants, the analysis highlights the **multi-level governance structure** in the Eurodelta region. The effectiveness of circular economy initiatives depends on fostering engagement across all levels, ensuring policy alignment, and leveraging the strengths of key players while enhancing the participatory role of supporters and observers.

Recommendations for Stakeholder Collaboration:

1. **Strengthen Multi-Stakeholder Forums:**

    - Enhance cooperation between **key players** (governments and infrastructure authorities) and **influencers** (research institutions, business networks) to co-develop policies for circularity.
2. **Empower Local Actors:**
    - Increase funding and capacity-building for **supporters** (local municipalities, sustainability organizations) to accelerate local implementation of circular strategies.
3. **Enhance Public Engagement and Awareness:**
    - Utilize digital platforms and stakeholder arenas to engage **observers** (citizens, media, activist groups) in circular economy discussions, ensuring widespread support and accountability.
4. **Cross-Border Governance Alignment:**
    - Foster greater collaboration between **national/regional governments and cross-border cooperation bodies** to harmonize circular economy policies and overcome regulatory barriers.

Conclusion

A well-structured stakeholder engagement framework is essential for transitioning towards a circular Eurodelta. Understanding the dynamics of influence and importance among stakeholders helps in designing effective governance models that drive circular economy initiatives while ensuring inclusive decision-making. The Influence-Importance Matrix provides a roadmap for strategic collaboration, ensuring that all stakeholders contribute effectively to the shared vision of a sustainable, cross-border urban future.

STAKEHOLDER MAPPING

After mapping out the layers and identifying different arenas and zones, the related stakeholders have been mapped, and their interactions have been visualized in the stakeholder mapping illustration below. This mapping provides a spatial representation of the relationships between different stakeholder groups, highlighting areas of influence, collaboration potential, and strategic engagement points.

This visual framework aids in identifying how different stakeholder categories interact with urban-industrial dynamics, cross-border cooperation efforts, and circular economy initiatives. It also serves as a basis for designing governance frameworks that effectively balance top-down policy implementation with bottom-up grassroots engagement.

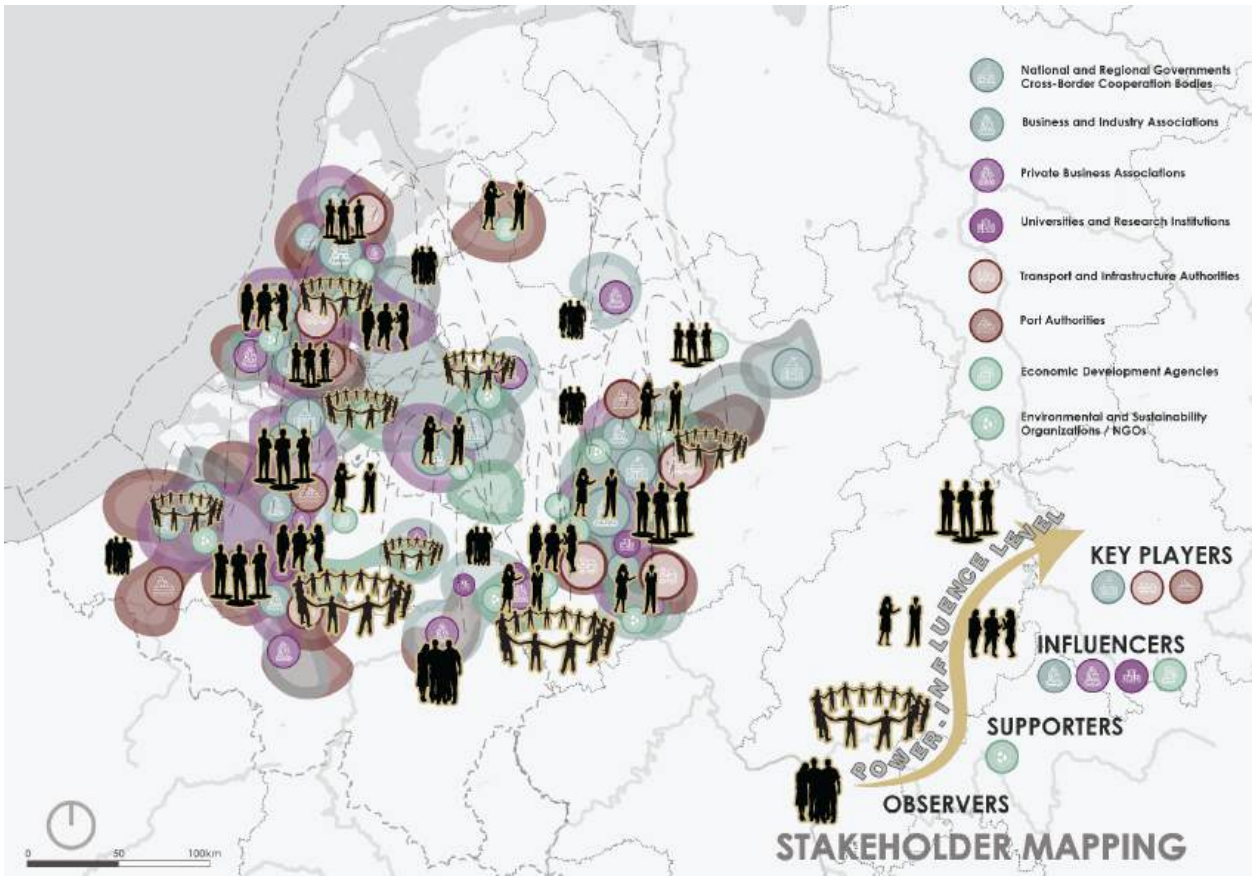

Figure16: Stakeholder Mapping

Conclusion

A well-structured stakeholder engagement framework is essential for transitioning towards a circular Eurodelta. Understanding the dynamics of influence and importance among stakeholders helps in designing effective governance models that drive circular economy initiatives while ensuring inclusive decision-making. The Influence-Importance Matrix provides a

roadmap for strategic collaboration, ensuring that all stakeholders contribute effectively to the shared vision of a sustainable, cross-border urban future.

PROPOSAL

VISION

1. MAIN CHALLENGES

After analyzing various mapping layers, key challenges were identified across different functional areas: **Urban, Industrial, Farmland, Port, and Cultural.** These challenges present significant obstacles to achieving a circular and sustainable Eurodelta.

Urban Challenges

- Unsustainable urban expansion and increasing population
- Predominance of linear economy business models
- Rising CO2 emissions
- Expensive and inefficient land consumption

Industrial Challenges

- Resource depletion and excessive waste production
- Lack of industrial symbiosis
- Scattered industrial clusters reducing efficiency
- Dependence on fossil fuel energy generation
- Wasted residual material flows

Farmland Challenges

- Unsustainable farming practices
- Minimal locally sourced food production
- Underutilization of organic waste
- Soil and water health management issues
- Increased vulnerability to droughts

Port Challenges

- Slow growth in cross-border connectivity
- Bottlenecks in rail-road infrastructure
- High infrastructure development costs
- Limited cross-mobility hubs

- Lack of streamlined reverse logistics systems
- Poor coordination among multifunctional industries

Cultural Challenges

- Cultural differences and lack of stakeholder engagement
- Challenges in preserving nature and natural resources
- Limited development in retreat and heritage areas
- Inaccessibility of natural landscapes
- Neglect of historical and cultural heritage

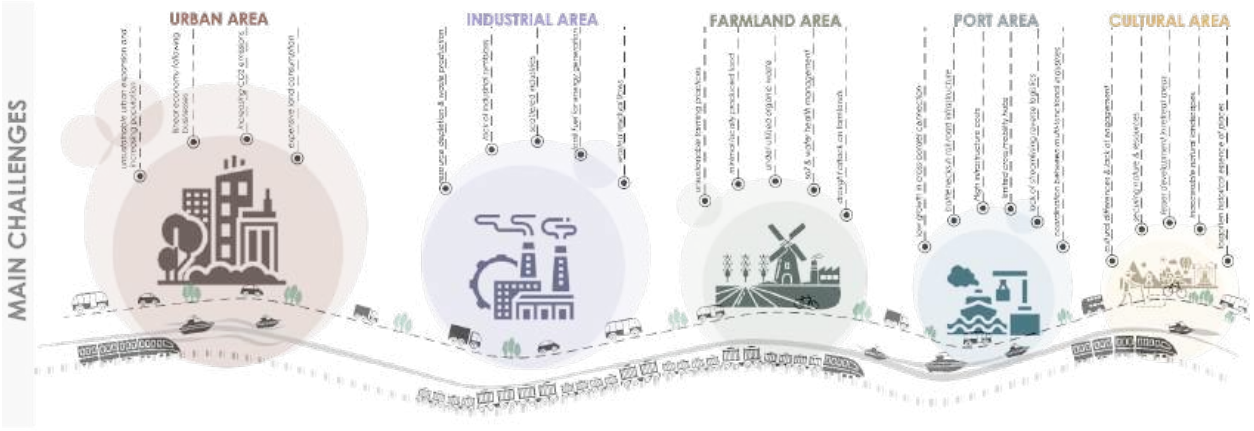

Figure17: Vision-Main Challenges

2. LONG-TERM GOALS

To address these challenges, the following key goals have been established for the Eurodelta's sustainable future:

- **Reducing waste production** and promoting urban mining through circular demolition practices
- **Developing manufacturing and construction hubs** for efficient reverse logistics
- **Increasing resource efficiency** through circular economic strategies
- **Encouraging industrial symbiosis** and shared infrastructure to reduce costs
- **Creating closed-loop systems** for material flows
- **Promoting organic farming methods** to improve soil health and food security
- **Preserving natural landscapes** and enhancing ecological connectivity

- **Enhancing cross-border infrastructure and connectivity** with new ports and mobility hubs
- **Advancing maritime industries** through sustainable logistics and operational strategies

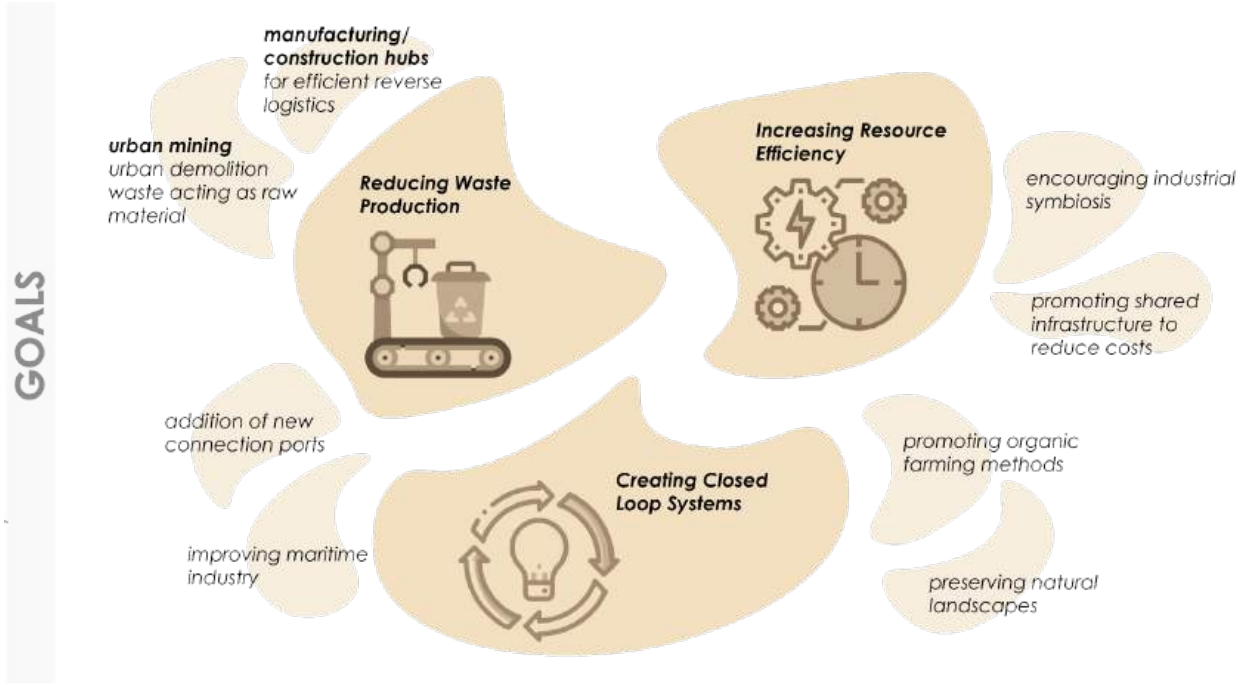

Figure18: Vision-Goals

3. PROPOSAL

"Development of closed loop systems with efficient production/processing cycle that integrates circular economy principles into fostering sustainable growth, resource efficiency and resilience in the Eurodelta region"

The vision hinges on the development of collaborative stakeholder arenas and frameworks that facilitate cooperation across cities and countries, enabling the region to overcome its fragmented urban governance and achieve sustainable urban development.

Collaborative stakeholder arenas will be key to shaping smarter, more efficient spaces for logistics, storage, processing, and production. By bringing together people, digital tools, and innovative frameworks, these spaces can seamlessly integrate advanced data and intelligent networks. The result? A dynamic, well-connected ecosystem that not only supports sustainable urban growth but also strengthens cross-border collaboration.

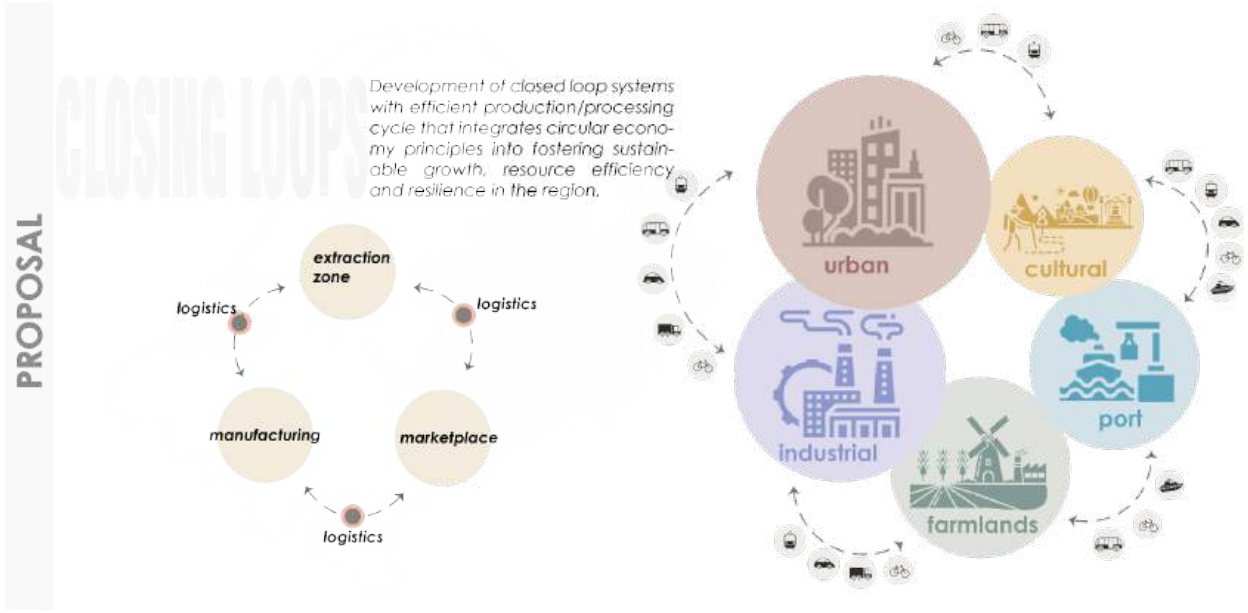

Figure19: Vision-Proposal

4. MAIN COMPONENTS- Main Structure

For a thriving economy, essential resources such as raw materials, energy, and efficient logistics must be accessible. These necessities are not abstract; they are embedded in the physical environment, influencing how we use land, develop infrastructure, and shape industries. However, the existing economic framework is largely linear—designed around extraction, consumption, and disposal. To build a truly circular economy by 2050, we need a **new spatial structure** that supports regenerative and closed-loop systems.

Redesigning the Backbone of a Circular Economy

Currently, the Eurodelta's infrastructure is built to serve a linear economic model. To transition toward circularity, this **main structure** must be adapted, integrating new systems that close resource loops and support sustainable growth. This transformation will require:

- **Zero-emission logistics and infrastructure** are vital for promoting low-carbon mobility, efficient supply chains, and smart transportation solutions within sustainable urban development. This framework not only supports reverse logistics but also helps establish zero-emission zones in urban areas, creating an interconnected network of clean transport options. These zones act as focal points for growth and development, aligning with the vision of fostering circular and sustainable urban environments in the Eurodelta region. By prioritizing green transport solutions, we can create more resilient, resource-efficient cities that contribute to a low-carbon future.

Figure 20: Zero emission infrastructure map

- **A well-integrated residual flow system** is key to minimizing waste and repurposing byproducts across industries, creating a more circular and sustainable urban ecosystem. For the circular economy to flourish, it's essential to ensure access to high-quality materials and raw resources. This means reducing reliance on primary supplies, improving waste separation directly at the source, and harnessing secondary materials from urban renewal areas. By doing so, we can create a more resilient, resource-efficient urban landscape that fosters collaboration and circularity, aligning with the broader goals of sustainable urban development within the Eurodelta region.

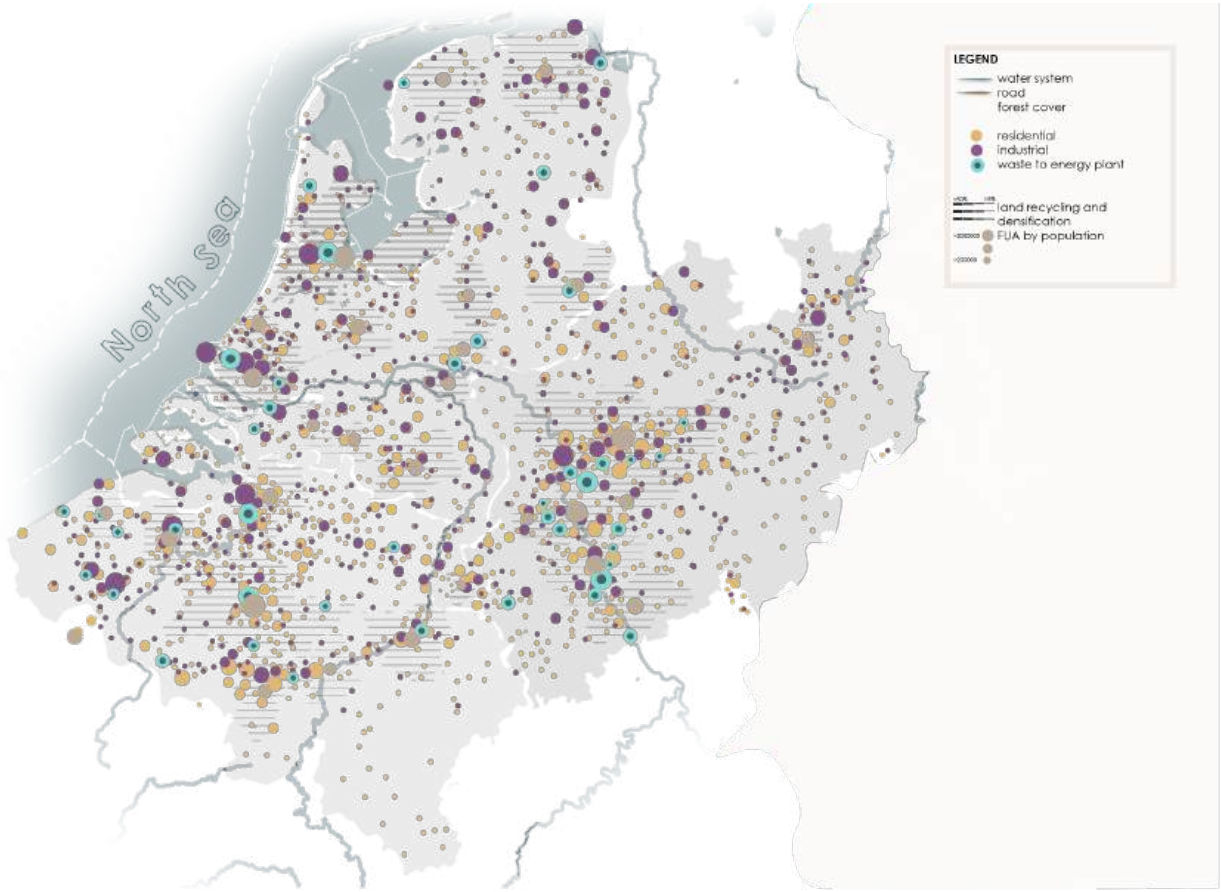

Figure 21: Residual Flow system map

- **A climate-resilient water and soil management system** that supports regenerative agriculture, biodiversity, and urban sustainability.Soil and water are foundational elements in driving spatial development, particularly within the context of sustainable urban growth. High-quality soil, enhanced through practices like green manure, is vital for resilient agriculture, which ties into the

principles of a circular economy. Similarly, fresh water is an essential resource that requires careful management. With the impacts of climate change, it's increasingly crucial to implement strategies for water buffering and reuse. Additionally, challenges like soil subsidence and salinization must be mitigated. To support a circular urban landscape, the water system needs to evolve into a more circular, adaptive, and resilient infrastructure—one that meets the needs of both urban areas and agricultural sectors, such as greenhouse horticulture.

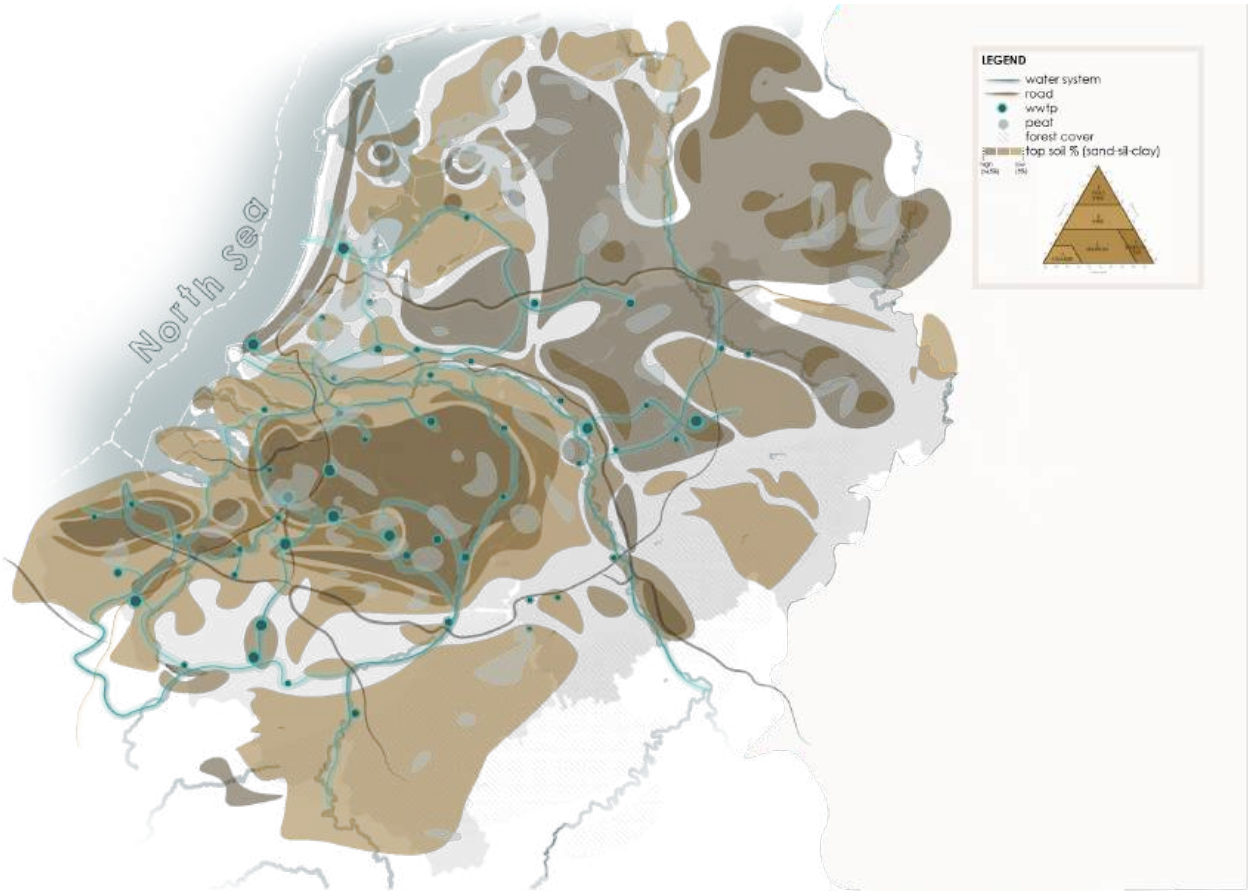

Figure 22: Healthy water and soil system map

- **A decentralized renewable energy network** that eliminates dependency on fossil fuels and promotes shared energy solutions. Electricity generated from offshore wind farms, along with potential hydrogen from the North Sea, will be integrated into the onshore infrastructure, contributing to a more sustainable and circular energy system. This energy will be supplemented by renewable sources on land, including wind turbines, rooftop solar panels, geothermal energy, and residual heat, which can be distributed through heat roundabouts or heating networks.

This interconnected, circular energy network aligns with the vision of fostering sustainable urban development by creating a resilient, resource-efficient system that supports both the energy needs of urban areas and the broader circular economy.

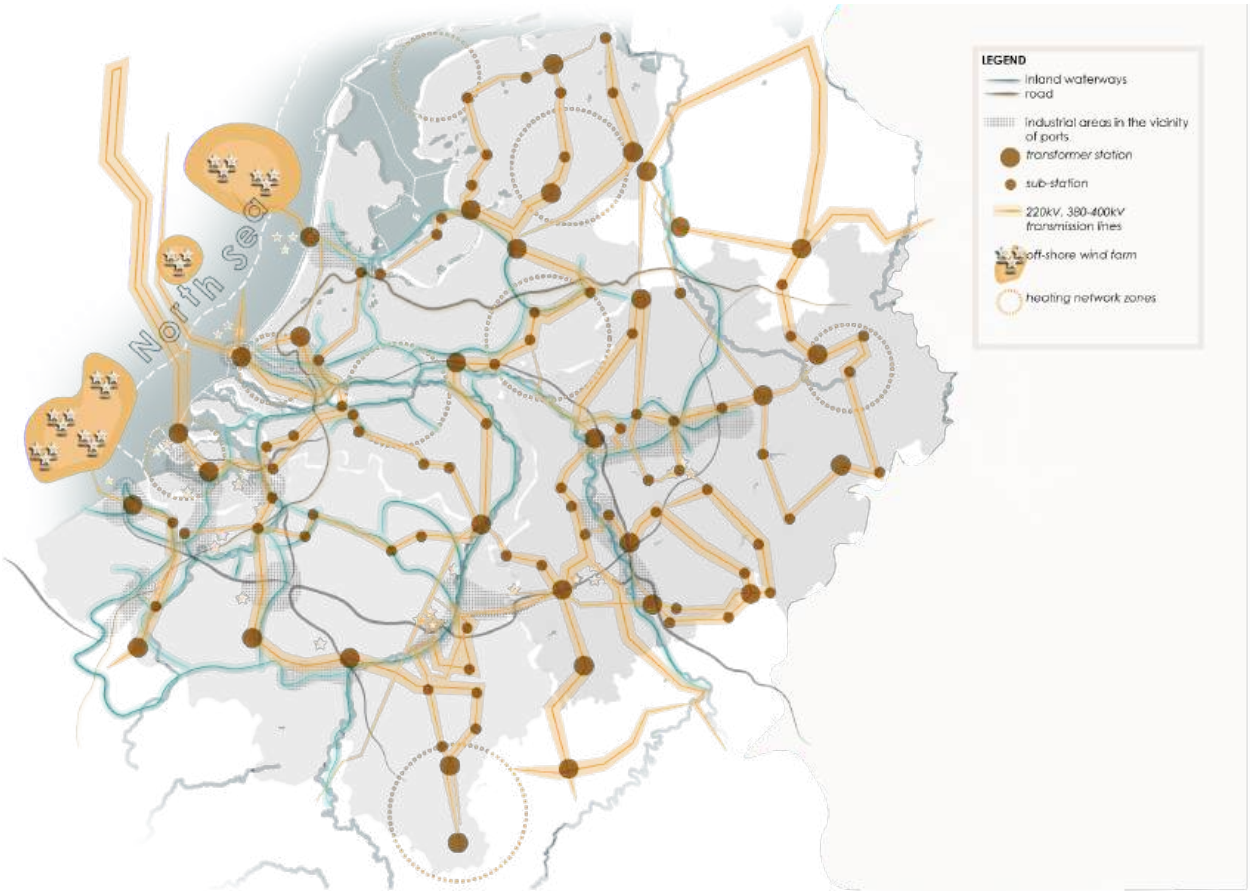

Figure 23: Renewable Energy Infrastructure map

Beyond these tangible systems, the success of a circular economy also depends on **knowledge-sharing, innovation, and digital integration**. Where multiple elements of this system converge—such as urban-industrial interfaces, port-city transitions, and rural production hubs—**circular innovation zones** emerge. These hotspots offer immense opportunities for cross-sector collaboration, bringing together material flows, processing hubs, and sustainable production in one interconnected ecosystem.

Scaling Circularity Through Collaboration

Building a circular backbone is not just a regional effort—it requires **cross-border coordination**. Key initiatives such as **hydrogen infrastructure, smart energy grids, and sustainable transport networks** must be developed at a transnational scale. By embedding circular principles into the core of the Eurodelta's spatial and economic systems, we can move beyond sustainability rhetoric and build a region that is **resource-efficient, resilient, and future-proof**. This aligns with existing frameworks like the **Multi-Year Programme for Infrastructure, Energy, and Climate (MIEK), Regional Energy Strategy (RES), and Multi-Year Programme for Infrastructure, Space, and Transport (MIRT)**.

5. MAIN COMPONENTS-Circular Spatial Chains

A. Production Cycle

In a circular economy, the focus is on creating cycles rather than following the traditional linear model of production and consumption. A *spatial chain* represents the development of a circular function, where production, consumption, and logistics are all interlinked and work together as a cohesive whole. Logistics systems play a crucial role in connecting these different functions, making them essential in driving circular processes.

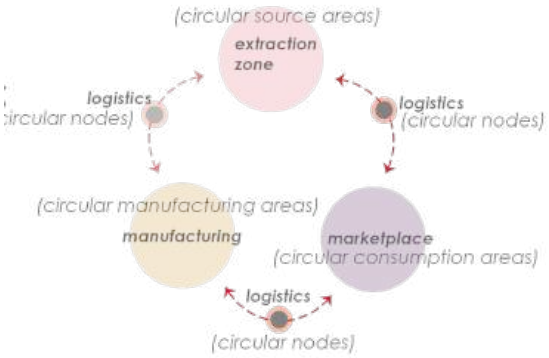

Figure 24: Production Cycle

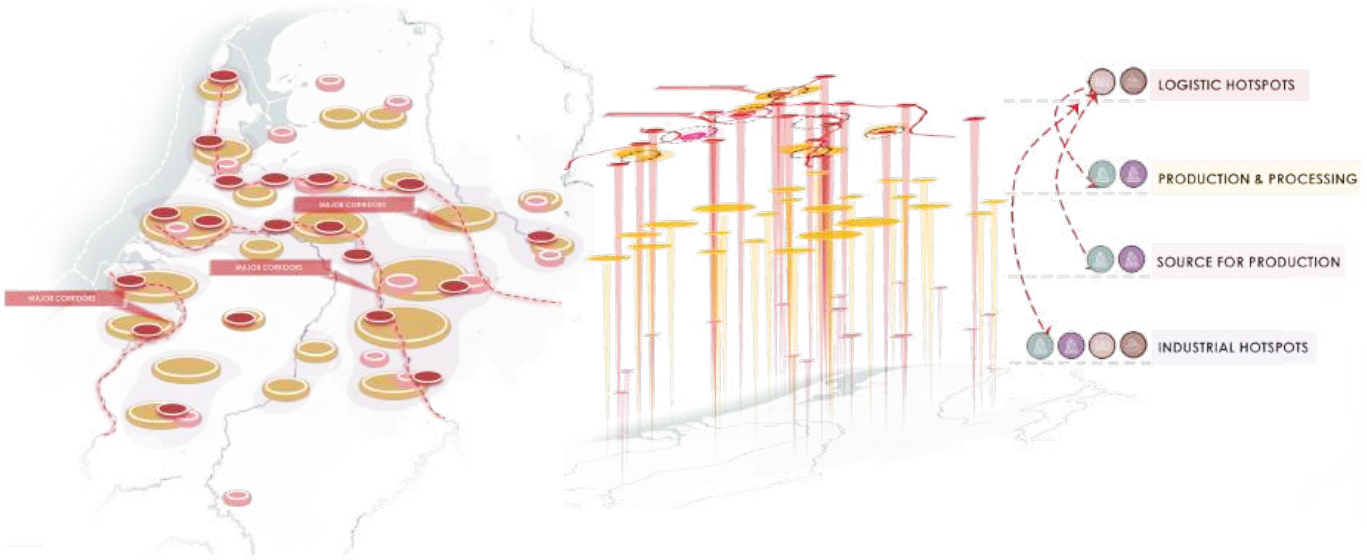

Figure 25: Illustration of various production cycle zones

Drawing from the Circular South Holland Strategy, which proposes a logistically linked production cycle, a modified version of this cycle can be applied to urban development in the Eurodelta region. This cycle includes four key zones:

- ➔ **Extraction Zone (Circular Source)**: This is where primary (biobased) and secondary raw materials are harvested and extracted to serve as inputs for circular chains. It could involve things like crop residues or reclaimed demolition materials that provide resources for further processing.
- ➔ **Production/Processing Zone (Circular Manufacturing)**: In this zone, raw materials are processed, refined, and turned into semi-finished products or goods. Activities like rinsing, drying, sorting, chopping, printing, and assembling all contribute to transforming materials into new products, adding value at each step.
- ➔ **Marketplace Zone (Circular Consumption)**: These are areas where products are consumed, such as circular residential communities. Here, consumption is closely linked with the return flows of secondary raw materials and resources, creating a continuous loop where materials are fed back into the system for reuse.
- ➔ **Logistics Zone (Circular Nodes)**: This zone serves as the hub for gathering, storing, exchanging, and distributing both primary and secondary raw materials. Logistics networks act as nodes that connect different stages of the circular process,

ensuring materials flow efficiently between extraction, production, and consumption areas.

By connecting these zones through circular spatial chains, urban areas can foster sustainable growth, improve resource efficiency, and reduce waste. This approach aligns with the vision of creating collaborative frameworks and spatial strategies that support circular urban development across the Eurodelta region.

B. Scale VS Spatial Chains

Spatial chains vary in both their area of application and scale, ranging from local to global levels. These scales can range from *Ground Zero* (home or individual scale) to *Ground Fifty* (regional scale), and *Ground Hundred* (international scale), with multiple layers in between that reflect different levels of interconnectedness and complexity.

- **Ground Zero (Home Scale)**: This represents the smallest unit of spatial chains, such as a single household or community. For example, a household that practices waste separation and composting, reusing materials for household projects, and supporting local circular initiatives like food sharing or local recycling programs.
- **Ground Fifty (Regional Scale)**: This scale involves a broader, more complex system, such as a city or a specific region. An example would be a city with district-wide initiatives that encourage circular building practices, urban farming, and the sharing of resources across neighborhoods, where waste and byproducts from one industry or neighborhood are repurposed for another.
- **Ground Hundred (International Scale)**: At this scale, the spatial chains involve cross-border or international systems. For example, international supply chains that facilitate the exchange of secondary raw materials or products between countries, where waste flows from one region are turned into resources in another, and global energy networks connect offshore wind farms with mainland cities.

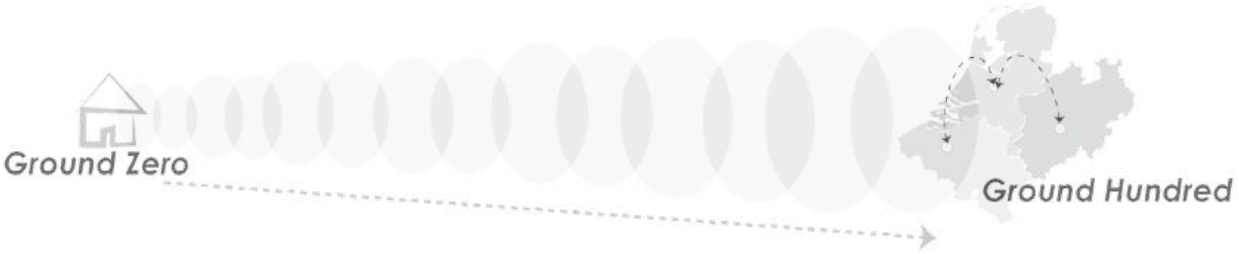

Figure 26: Illustration of Scale VS Spatial

Each scale operates within its own unique framework, yet they are interconnected, creating a seamless flow of resources and supporting a circular economy from the local level all the way to the global stage. These interconnected layers contribute to a more resilient and sustainable system, echoing the vision of a circular urban development strategy across the Eurodelta region.

6. MAIN COMPONENTS-Circular Arenas For Collaboration

Circular arenas are spaces where multiple functional areas, each with its own unique characteristics, come together to foster collaboration and innovation. These arenas are diverse, with each offering its own set of circular opportunities and tasks, and sometimes even combining different areas of focus.

- **Functional Diversity**: Each arena is shaped by a variety of sectors, such as waste management, energy, urban planning, or agriculture. For example, a circular arena could be a mixed-use urban district where sustainable building practices, renewable energy systems, and local food production are all integrated.
- **Collaboration and Knowledge Exchange**: These arenas serve as platforms for collaboration, where stakeholders from various sectors, industries, and communities can meet, exchange knowledge, and work together. A good example is a circular business hub, where startups, researchers, and businesses focused on green technologies share ideas, test innovations, and co-develop solutions.
- **Stakeholder Engagement**: At the core of these arenas is active engagement from multiple stakeholders. This could include local governments, private sector players, community organizations, and citizens. For instance, a city-wide initiative

to promote circular waste management might involve local authorities, waste management companies, residents, and environmental groups working together to design and implement solutions.

- **Cumulative Decision-Making**: In circular arenas, decision-making is often cumulative, drawing on the collective input of all involved parties. An example might be a regional circular economy strategy, where decisions about resource sharing, waste reduction, and sustainable infrastructure are made collaboratively across different sectors and levels of governance.

These circular arenas function as dynamic spaces where collaboration and shared knowledge drive the transition to a more circular and sustainable future, aligning with the vision of fostering cooperative frameworks and integrated approaches to urban development in the Eurodelta region.

7. PHASES OF DEVELOPMENT

The development of a circular urban system is structured in distinct phases, each with its own objectives and milestones. These phases span from initial preparations to the full implementation of a circular ecosystem that connects and circulates resources across regions.

- **Kickstart (2025-2027)**: This initial phase focuses on laying the foundation for future circular development. The goal is to kickstart key projects, establish foundational structures, and begin building the networks that will drive the circular economy forward. During this time, the focus will be on setting up the systems needed for resource flow, establishing partnerships, and starting small-scale initiatives.
- **Connect-Accelerate-Scale (2027-2032)**: In this phase, the first tangible steps toward building, converting, and dismantling are taken. The aim is to connect different circular initiatives, accelerate progress, and scale up successful pilot projects. Key activities include preparing spatial choices and infrastructure that will support further development and long-term sustainability, with a focus on integrating circular practices into urban spaces and industries.
- **Build-Up-Convert-Dismantle (2032-2042)**: This phase marks the implementation of the decisions and strategies developed in the earlier stages. It's about building up circular systems, gradually phasing in circular practices, and dismantling outdated linear models. The focus will be on adapting existing structures, transitioning to circular practices, and ensuring that resources flow seamlessly

through the system. This phase will also involve deepening collaboration across sectors and regions to ensure scalability and sustainability.

- **Circular Ecosystem (2042-2052)**: In the final phase, a fully developed circular

Figure 27: Illustration of Phases of development

- ecosystem will emerge. This ecosystem will consist of interconnected spaces where renewable resources are circulated efficiently between source areas and processing hubs. It will be a finely branched system, with resource flows seamlessly moving across urban areas, industrial zones, and agricultural regions.

The system will be highly resilient, adaptive, and capable of supporting long-term circular practices, creating a balanced and sustainable urban environment.

Each phase builds upon the previous one, progressing toward a circular and sustainable future, aligned with the vision of fostering collaborative frameworks, resilient infrastructure, and circular urban development in the Eurodelta region.

8. FINAL VISION MAP

The Final Vision Map illustrates how the circular spatial chain operates, showing the flow of resources and processes across different stages of urban and regional development. It integrates multiple elements of circularity into a cohesive system, ensuring sustainability at every level.

- **Pre-Conditions for Strengthening the Main Structure**: This initial phase involves preparing the foundational elements necessary for a circular system to thrive. It's about creating the preconditions that allow the main structure to function effectively. This includes identifying and utilizing key hotspots within the urban and regional framework that will drive circular practices forward.
- **Main Structure: Bringing Pre-Conditions into Action**: Once the foundation is set, the next step is to bring these preconditions into practice. This phase focuses on embedding circularity into the urban fabric and making it functional. It involves integrating various hotspots into the main structure and actively implementing circular processes, from resource management to urban design.
- **Logistics Space (Circular Distribution Areas)**: The logistics space connects the entire system by facilitating the distribution and movement of materials. This includes the creation of a circular hub system and efficient networks, such as zero-emission freight corridors across roads and waterways, ensuring that the transportation of materials is sustainable and energy-efficient.
- **Realizing Circular Chains and Spatial Links**: This phase is about translating the theory into practice, making the circular chains and spatial connections a reality. It focuses on the key areas where circular processes will be applied and strengthened:
    - **Extraction/Harvest Area (Circular Sources)**: Urban areas are developed for urban mining, allowing the extraction of valuable materials from waste. Additionally, multi-functional circular cultivation spaces are created,

enabling sustainable agriculture and resource use within urban environments.

- **Production/Processing (Circular Processing/Valorization)**: Valorization locations are established for bio-flows, where organic waste is turned into valuable resources like bioenergy or compost. Circular maritime logistics are developed, and spatial reorganization takes place to create a more sustainable industrial environment that minimizes waste and maximizes resource reuse.
- **Usage/Marketplace (Circular Consumption)**: This is where circularity meets daily life. Circular interventions are applied in usage spaces—such as residential areas, commercial spaces, and public infrastructure—making it easier for individuals and businesses to adopt sustainable practices. Innovation and knowledge clusters are developed to foster collaboration, research, and the creation of new circular solutions.

Each stage of the map builds upon the previous one, creating a comprehensive, interconnected system that fosters a circular economy and sustainable urban development, in line with the broader vision of transforming the Eurodelta region into a resilient, resource-efficient space.

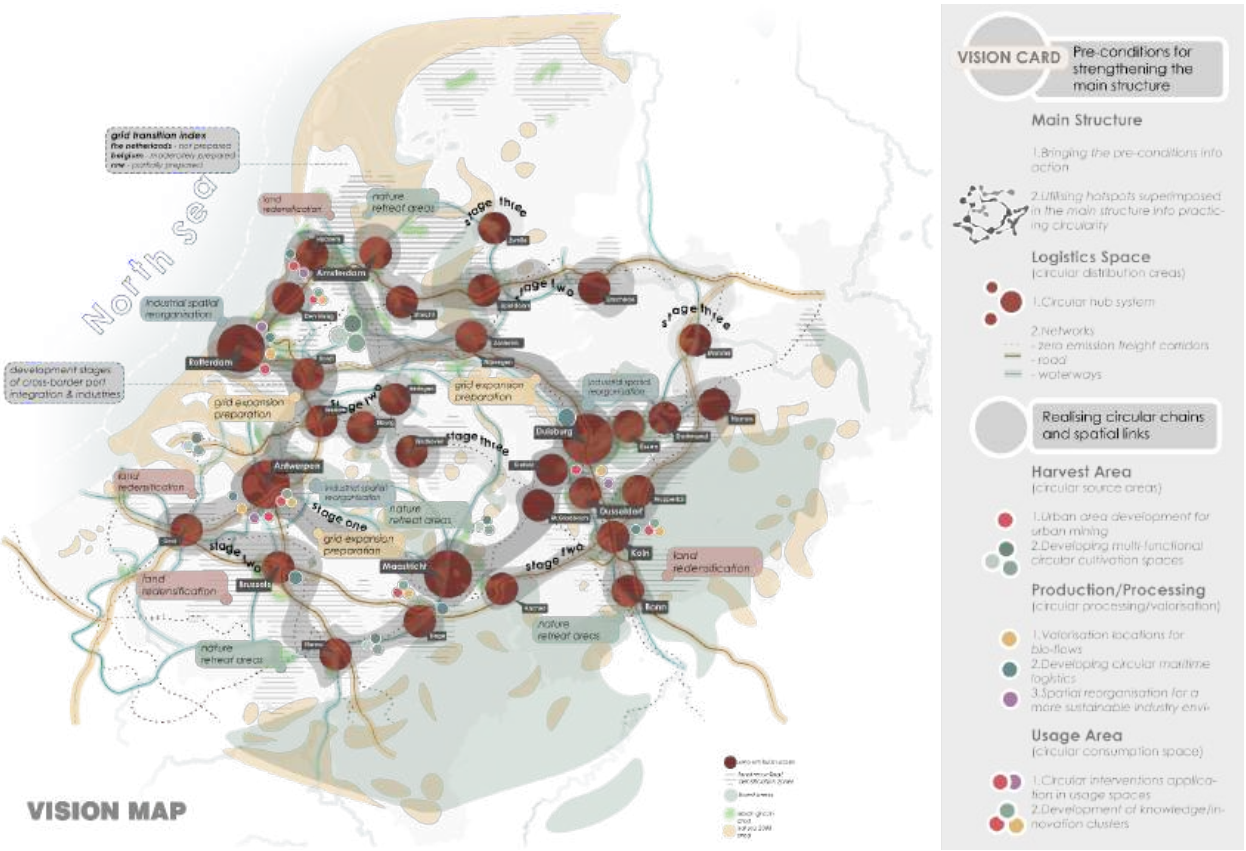

Figure 28: Vision Map

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STRATEGIES

1. CIRCULAR ARENA TOOLKIT OF INTERVENTIONS

To bring the circular vision to life, a set of targeted strategies and toolkits have been developed for different circular arenas. Each arena has unique functions and challenges, requiring tailored solutions that enable resource flows and interdependencies.

For each of the four identified circular arenas—**Circular Urban Arena, Circular Port-Industrial Arena, Circular Agri-Vini Arena, and Circular Energy Arena**—a specialized toolkit is designed. These toolkits act as enablers, offering practical strategies for resource reuse, efficient material flows, and cross-sector collaboration.

- **Circular Urban Arena(URBAN CHAIN)**: Focuses on urban regeneration, with strategies such as biobased construction and urban mining. For example, in urban demolition zones, materials like reclaimed wood and recycled concrete are repurposed for new construction.

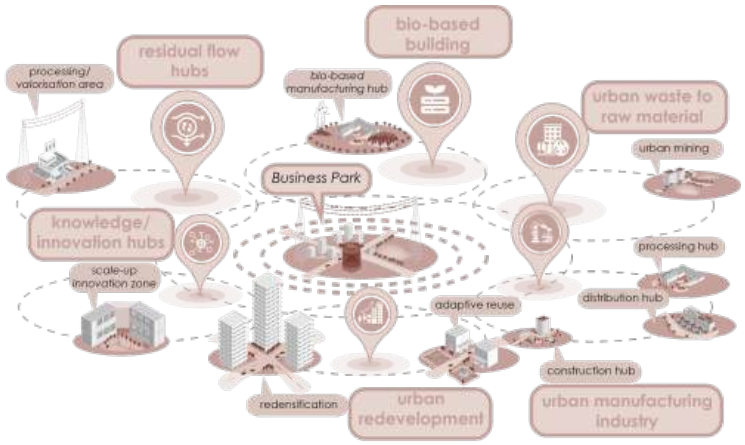

Figure 29: Urban Toolkit

- **Circular Port-Industrial Arena(PORT-INDUSTRIAL CHAIN)**: Supports industrial symbiosis, ensuring that byproducts from one industry become resources for another. Ports play a crucial role in managing the flow of materials, energy, and logistics efficiently.

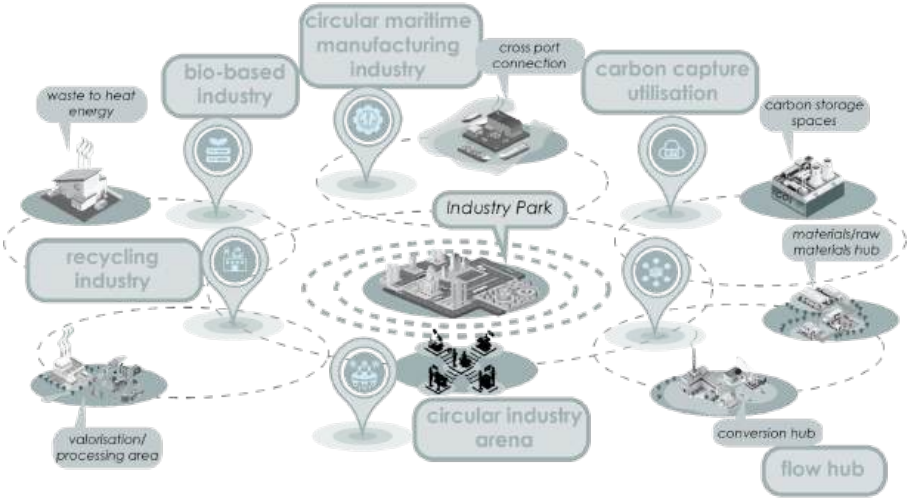

Figure 30: Port-Industrial Toolkit

- **Circular Agri-Vini Arena(AGRI-VINI CHAIN)**: Strengthens sustainable agricultural and viticultural practices through regenerative farming, waste-to-resource cycles, and localized food production models.

Figure 31: Agri-Vini Toolkit

- **Circular Energy Arena(ENERGY CHAIN)**: Integrates renewable energy sources—solar, wind, hydrogen, and waste heat—into urban and industrial systems, ensuring a balanced and resilient energy network.

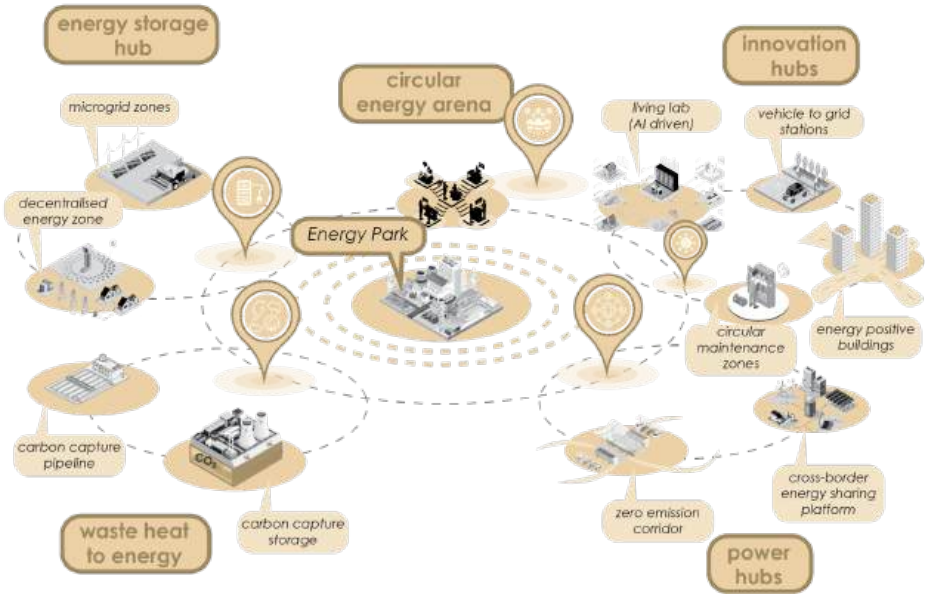

Figure 32: Energy Toolkit

These toolkits are designed to be applied to specific zones based on their functions. For instance, the **urban toolkit** can be used in a **demolition zone**, promoting biobased and recycled materials for construction. The toolkits serve as a guide for interventions, connecting different sectors to establish a truly circular system.

2. FINAL STRATEGIES MAP

A **final strategies map** has been created, identifying key zones across three countries—**The Netherlands, Belgium, and Germany**—that hold the highest potential for circular transformation. The selected zones correspond to major port cities:

- **Port of Rotterdam, Netherlands**
- **Port of Antwerp, Belgium**
- **Port of Duisburg/Düsseldorf, Germany**

Each of these zones has been analyzed in detail, mapping out crucial layers such as **mobility networks, industrial and residential areas, cultural hotspots, water treatment plants, landfills, and leisure spaces**. By overlaying these layers, **key toolkit zones** have

been identified, where necessary **spatial reorganizations** and **circular interventions** have been proposed. This ensures **efficient and economic resource flows**, supporting the transition to a fully circular system.

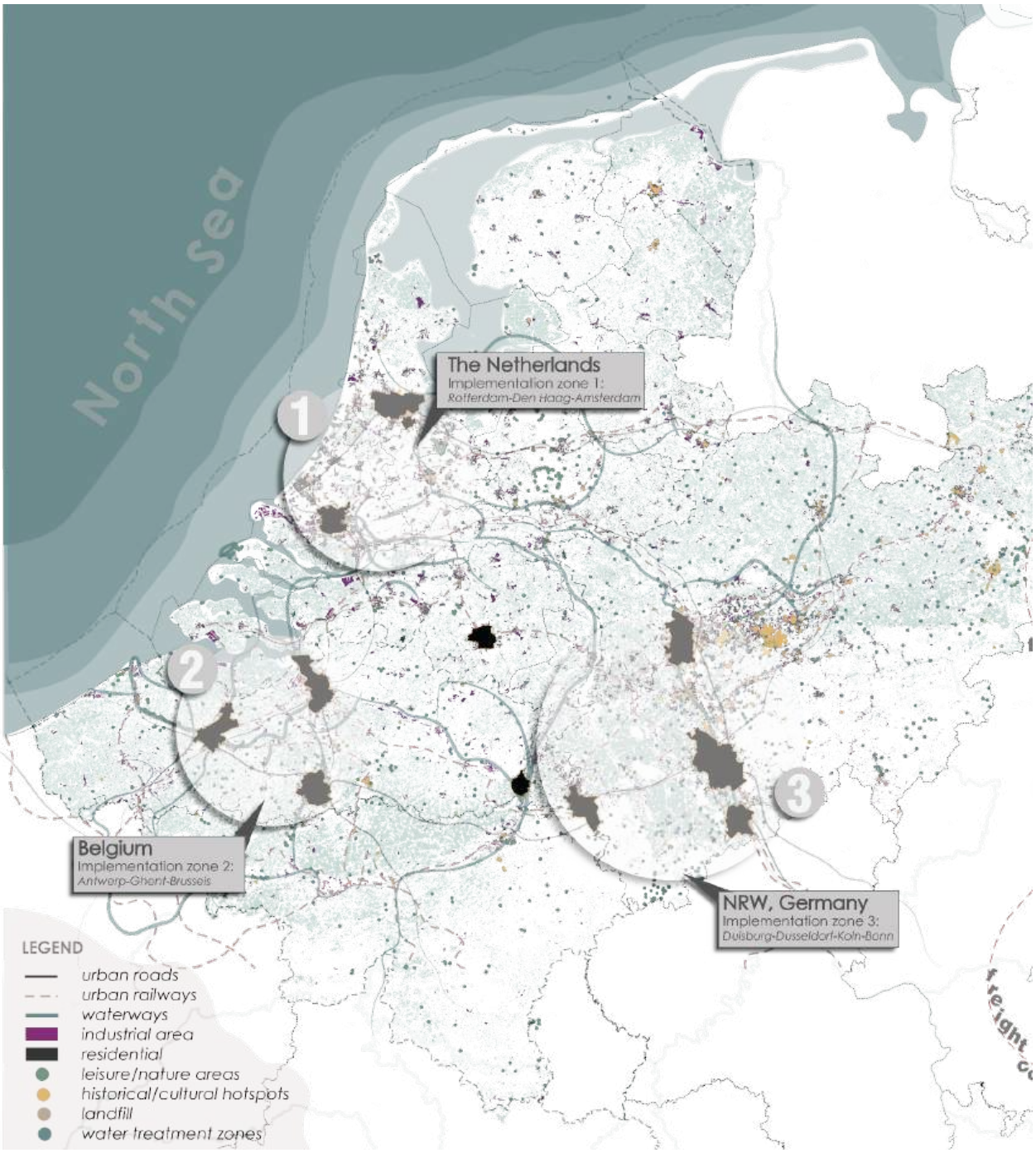

Figure 33: STrategies map

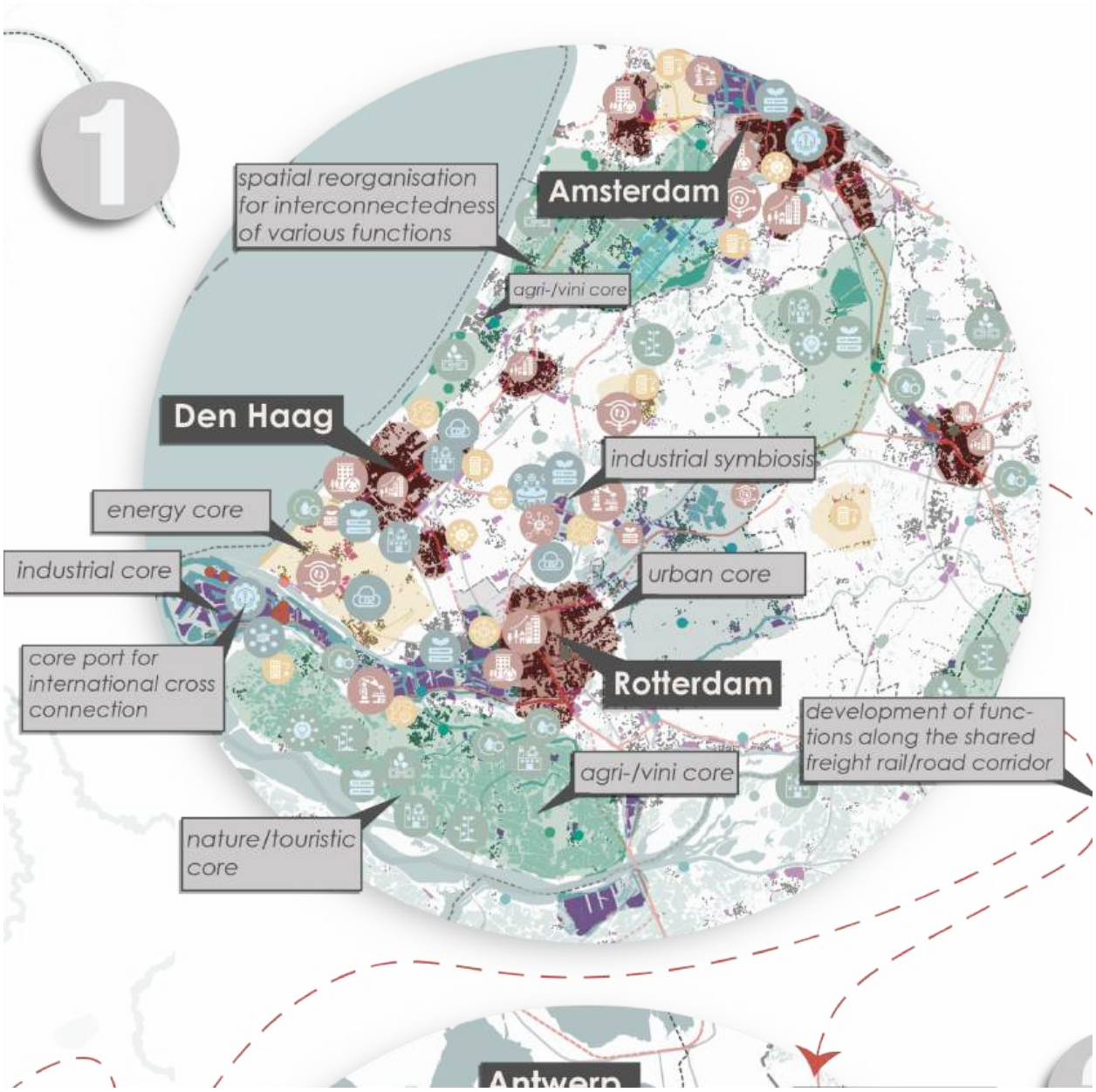

Figure 34: Detail Map 1-The Netherlands

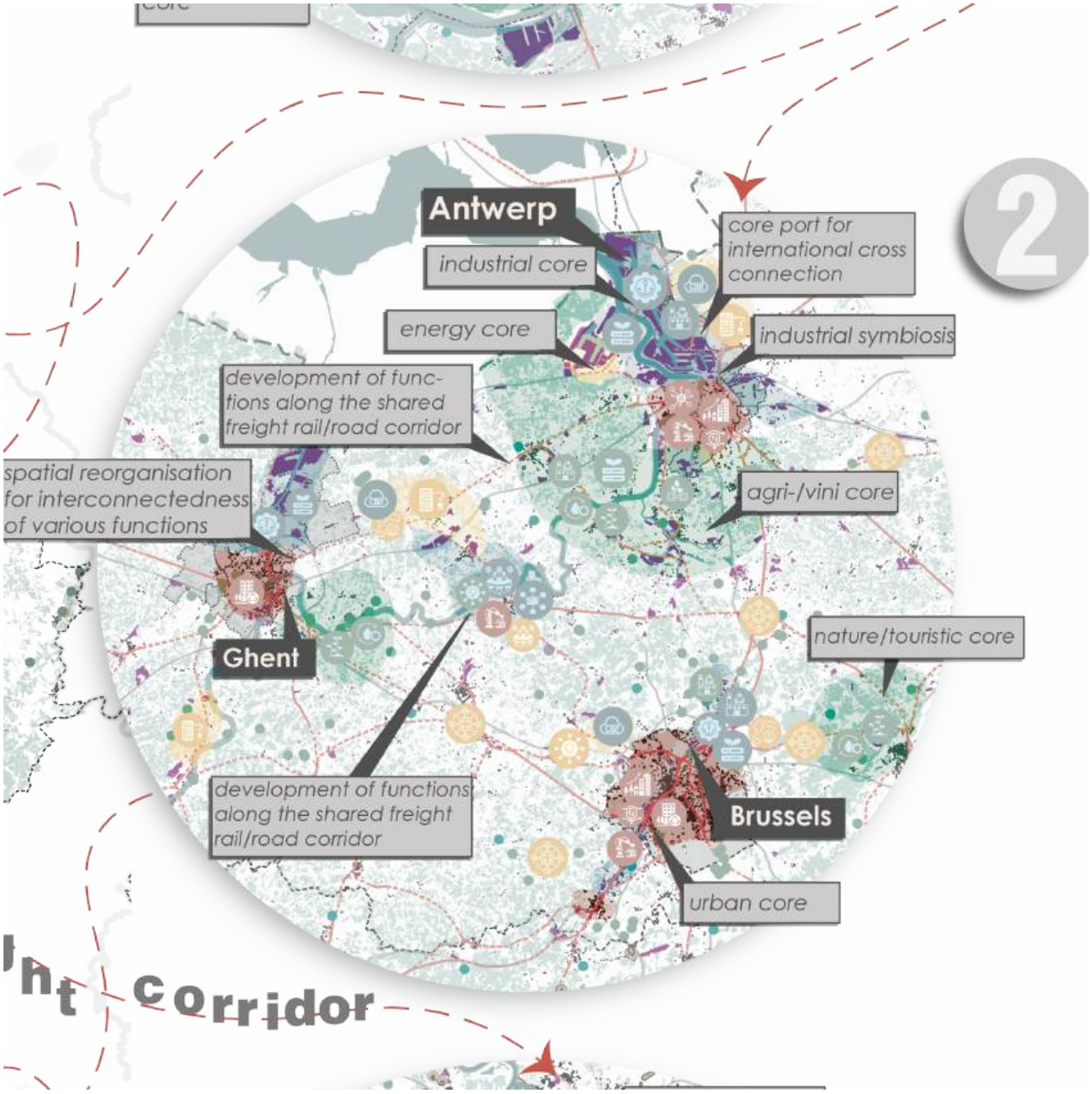

Figure 35: Detail Map 2-Belgium

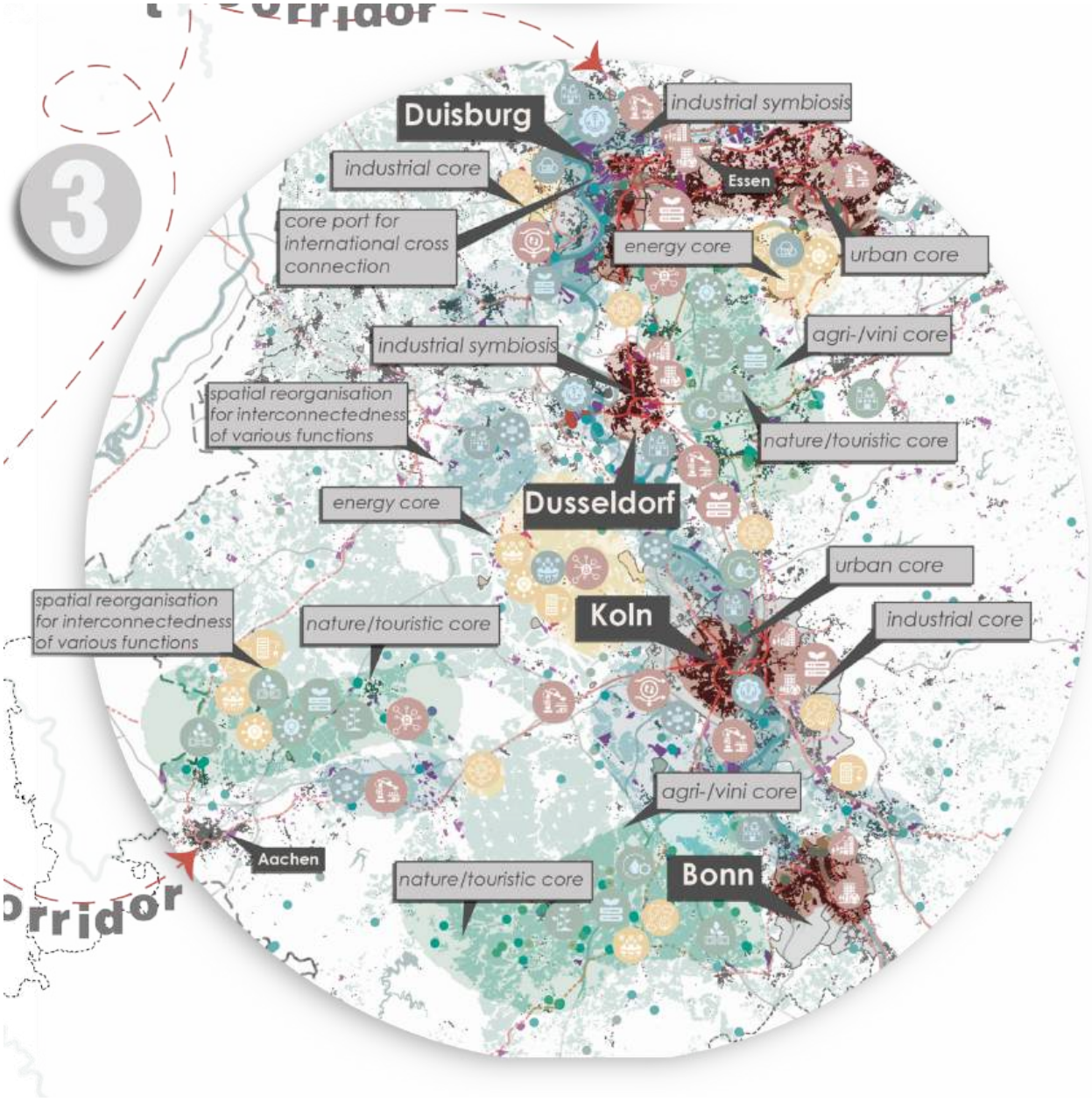

Figure 36: Detail Map 3-NRW, Germany

3. SCENARIOS

To illustrate how these circular arenas function, **scenarios** have been drawn to capture their essence. These scenarios provide a **narrative-driven approach**, helping visualize how different arenas interact, evolve, and shape the future of circular urban and regional development. Whether it's an urban area repurposing its construction waste, a port leveraging industrial symbiosis, or an agricultural zone maximizing regenerative cycles, these scenarios highlight the dynamic potential of circular spatial planning.

By implementing these strategies, the Eurodelta region can move toward a more **resilient, interconnected, and resource-efficient** future, where circularity is embedded in every aspect of spatial development.

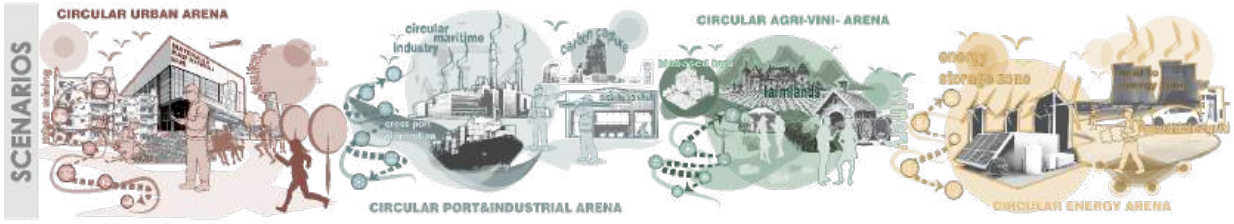

Figure 37: Scenario Illustration

DISCUSSION

CONCLUSION

Unlocking the Circular Future of the Eurodelta

The transition to a circular economy within the Eurodelta region is not just an environmental necessity but a strategic opportunity to redefine urban and regional development. Through the integration of circular spatial chains, collaborative arenas, and specialized toolkits, this research has outlined a comprehensive framework for fostering cross-border cooperation, resource efficiency, and sustainable growth.

By **reimagining urban, industrial, agricultural, and energy systems**, we can establish **a resilient, interconnected, and self-sustaining circular ecosystem**. The **Final Vision Map** and **strategic interventions** illustrate how different zones, industries, and stakeholders can work together to close resource loops, reduce waste, and optimize material flows. The **phased approach**, from kickstarting initiatives to scaling up and embedding circularity, ensures a **structured yet adaptable transition** toward a sustainable future.

Key regions, such as **Rotterdam, Antwerp, and Duisburg/Düsseldorf**, serve as anchor points for transformation, leveraging their logistical and industrial strengths to pioneer circular innovation. These strategic hubs will not only enhance local sustainability but also reinforce the **Eurodelta's position as a global leader in circular urbanism**.

However, the success of this vision depends on **collaborative governance, stakeholder engagement, and continuous adaptation**. Circularity is not a static goal but a dynamic process that requires ongoing investment in innovation, policy alignment, and participatory decision-making. By fostering **multi-stakeholder partnerships and knowledge-sharing**, we can ensure that circular principles become deeply embedded in urban and regional planning.

Ultimately, this research presents a **blueprint for systemic change**, demonstrating that **circularity is not just about sustainability—it is about creating a more efficient, equitable, and future-proof Eurodelta**. The challenge now lies in translating this vision into action, bridging the gap between ambition and implementation. With the right strategies, governance structures, and shared commitment, the Eurodelta can serve as **a model for circular urban development, shaping a thriving and regenerative future for generations to come**.

CRITICAL REFLECTION

Navigating the Complexities of Circular Urban Development

While this research presents a comprehensive framework for embedding circularity into the Eurodelta's spatial and governance structures, the transition to a circular economy is inherently complex and filled with challenges. The vision outlined in this thesis is ambitious, yet its implementation requires navigating multiple layers of spatial, economic, and political constraints.

One of the primary challenges is **cross-border collaboration**. The Eurodelta spans multiple national jurisdictions, each with distinct governance structures, economic priorities, and regulatory frameworks. Aligning policies, coordinating stakeholders, and fostering a shared commitment to circularity requires **strong institutional mechanisms and continuous dialogue**. Without this, there is a risk that circular efforts remain fragmented rather than forming a cohesive, cross-regional strategy.

Additionally, **spatial and infrastructural transitions take time**. While circular urbanism promotes efficiency and long-term sustainability, the reality of **retrofitting existing infrastructure, redesigning urban spaces, and integrating circular logistics networks** is complex. Cities and regions face competing land-use pressures, financial limitations, and social acceptance barriers that may slow down or complicate implementation.

Another critical aspect is the **economic viability of circular strategies**. Circular development must strike a balance between environmental benefits and economic incentives. **Scaling up circular business models, ensuring financial feasibility, and fostering market-driven approaches** will be crucial to attract investment and encourage private sector participation. Without economic backing, circular ambitions may struggle to transition from conceptual frameworks to practical applications.

Moreover, **stakeholder engagement and behavioral shifts** remain pivotal yet challenging. While this research emphasizes the importance of collaboration and participatory governance, real-world implementation requires **changing deeply rooted practices and mindsets**. From policymakers to businesses to citizens, each actor must see tangible value in circular approaches to drive sustained engagement and adoption.

Despite these challenges, this research offers **a strong starting point** for shaping the Eurodelta's circular future. The strategies and spatial frameworks outlined provide a **scalable and adaptable** model that can evolve over time. However, the ultimate success of circular urbanism depends on continuous **learning, experimentation, and flexibility**. Policymakers, planners, and industries must remain open to iterative processes, embracing **policy innovation, technological advancements, and socio-economic shifts** to refine and expand circular initiatives.

In conclusion, while the road to a fully circular Eurodelta is **complex and nonlinear**, the potential benefits—**resource efficiency, resilience, economic prosperity, and environmental regeneration**—make this transition essential. The vision laid out in this thesis is not an endpoint but a **catalyst for further dialogue, research, and action**. With a collective commitment and adaptive governance, the Eurodelta can pioneer a **transformative shift** toward a circular and sustainable future.

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LIST OF FIGURES

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ANNEXURE

INTERVIEW FORMAT AND TRANSCRIPTS

Interview format is as below:

Objective: To gather expert insights on circular economy implementation, cross-border collaboration, and stakeholder engagement in the Eurodelta region.

Interview Format

- Duration: 45 minutes
- Sections: Background, Circular Economy, Collaboration, Stakeholder Engagement, Vision

Introduction (5 Minutes)

Purpose of the Interview: "Thank you for taking the time to speak with me today. The purpose of this interview is to gather your insights to support my thesis on fostering cross-border collaboration and circular economy strategies in the Eurodelta region. Your input will significantly contribute to designing actionable strategies for the region."

Overview:

- Duration: 45 minutes
- Format: Structured and open-ended questions across five sections.
- Confidentiality: "Your responses will be anonymized unless you grant permission otherwise."

---

1. Expert Background (5 Minutes)

Q1: What is your primary area of expertise?

- (a) Circular economy
- (b) Sustainable urban development
- (c) Both equally
- (d) Any other
- Follow-Up: Could you share a key project or experience that exemplifies your expertise?

Q2: Have most of your projects been:

- (a) Regional
- (b) National
- (c) Cross-border
- Follow-Up: Can you provide an example of a cross-border initiative and its impact?

---

2. Circular Economy in Practice (10 Minutes)

Q3: Rank the following challenges in implementing circular economy principles from 1 (most significant) to 4 (least significant):

- Governance fragmentation
- Lack of stakeholder awareness
- Resource inefficiency
- Technological gaps
- Any other
- Follow-Up: Could you elaborate on your top-ranked challenge and suggest ways to address it?

Q4: How can material flows in sectors like construction or agriculture be optimized to reduce waste and resource inefficiency?

- Follow-Up: Are there any specific policies or tools that you recommend?

Q5: Have you worked with or observed the use of the following technologies? (Select all that apply):

- (a) IoT
- (b) GIS mapping
- (c) Blockchain
- (d) Other (please specify)
- Follow-Up: Which technology do you think has had the most tangible impact and why?

Q6: Can you share a successful example of material flow optimization or industrial symbiosis?

Follow up- What tools or datasets are most effective for tracking material flows? (Open-ended)

---

3. Cross-Border Collaboration (10 Minutes)

Q7: From your perspective, what is the most significant barrier to cross-border collaboration?

- (a) Policy misalignment
- (b) Cultural differences
- (c) Economic competition
- (d) Lack of communication
- Follow-Up: Can you share an example of how this barrier has played out?

Q8: How can governance frameworks be improved to facilitate harmonized circular economy policies across Belgium, the Netherlands, and NRW-Germany?

Q9: How effective do you believe EU-level institutions are in bridging governance and policy gaps?

- (a) Very effective
- (b) Moderately effective
- (c) Minimally effective
- (d) Not effective at all
- Follow-Up: What actions could make them more effective?

---

4. Stakeholder Engagement and Arenas (10 Minutes)

Q10: Which of these factors is most critical to successful stakeholder collaboration?

- (a) Trust and transparency
- (b) Shared goals
- (c) Financial incentives
- (d) Access to knowledge and resources
- Follow-Up: Could you provide an example of a project where this factor was particularly influential?

Q11: Do you think physical, or digital stakeholder arenas are:

- (a) Equally effective
- (b) Physical arenas are more effective
- (c) Digital arenas are more effective
- Follow-Up: What specific design features or practices have you found most effective in fostering participation?

Q12: What incentives are most effective for engaging diverse stakeholders, especially smaller businesses and communities?

---

5. Vision and Future Outlook (5 Minutes)

Q13: How achievable do you think a fully circular Eurodelta by 2050 is?

- (a) Very achievable
- (b) Somewhat achievable
- (c) Neutral
- (d) Somewhat unachievable
- (e) Not achievable
- Follow-Up: What key milestones would need to be met to achieve this vision?

Q14: How can this region leverage its unique strengths (e.g., ports, industrial clusters) to become a circular economic hub?

Q15: What emerging trends or technologies do you think will play a critical role in driving circularity over the next decade?

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6. Case Study Recommendation (5 Minutes)

Q16: Could you share a case study or project interventions that drove towards successful circular economy in the Eurodelta or in any other region?

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7. Conclusion and Closing (5 Minutes)

Q17: Do you have any additional insights or recommendations that could strengthen my research?

Q18: Would you be open to future collaboration or follow-up discussions as my thesis progresses?

Closing Statement: "Thank you for sharing your valuable insights. Your expertise will significantly contribute to my thesis and help shape actionable strategies for the Eurodelta region."

Transcripts of the interviews

Refined Transcript 1

Introduction

Nitisha:

Thank you so much for volunteering to participate in my interview. I'd like to begin by asking about your background. What is your primary area of expertise? Is it circular economy, sustainable urban development, or something else?

Tanya Tsui:

Sure. My background is in architecture. I earned my bachelor's and master's in architecture and later completed a PhD focused on circular economy and cities. My work involves using digital tools like GIS to help cities make decisions within a circular economy framework. So, my expertise lies in the circular built environment, circular cities, and spatial data science.

Nitisha:

Could you share a key project or experience that exemplifies your expertise?

Tanya Tsui:

One project that stands out is called Timber Loops. It involved spatial optimization for circular construction hubs in Amsterdam. The research aimed to determine the optimal scale for these hubs. Should there be

one for the entire city, or one for each neighborhood? These hubs essentially act as warehouses that collect and redistribute construction waste for reuse. This type of initiative is being explored in the Netherlands, sometimes led by governments and sometimes by private companies.

Nitisha:

Have most of your projects been regional, national, or cross-border? Could you also provide an example of a cross-border initiative and its impact?

Tanya Tsui:

Most of my research has been regional, like the Timber Loops project, which covered the Metropolitan Region of Amsterdam. I've also worked at the national scale, analyzing waste flows. Regarding cross-border work, I participated in a European project called Pop-Makina, which focused on circular maker spaces across seven cities. While each city had its own maker space, there was cross-border learning between them. However, the projects themselves remained city or region-specific.

Circular Economy in Practice

Nitisha:

Let's talk about circular economy challenges. Could you rank the following from 1 (most significant) to 4 (least significant)? The challenges are: governance fragmentation, lack of stakeholder awareness, resource inefficiency, and technological gaps. I'll paste these in the chat for your reference.

Tanya Tsui:

Sure. I'd rank governance fragmentation as the most significant, followed by resource inefficiency, then lack of stakeholder awareness. Technological gaps are the least significant.

Nitisha:

Could you elaborate on your top-ranked challenge and suggest ways to address it?

Tanya Tsui:

Governance fragmentation is significant because circular economy is often treated as just another burden among many pressing issues faced by municipalities. In the Netherlands, competing demands for space—housing, energy, biodiversity, and circular economy—often lead to circular initiatives being deprioritized. Another aspect is the siloed nature of research and policymaking. There's a need for interdisciplinary studies that synthesize information across different fields, creating a holistic understanding of these challenges. For example, a single comprehensive study could integrate spatial requirements for circular economy, energy, and biodiversity, rather than examining them separately.

Nitisha:

How can material flows in sectors like construction or agriculture be optimized to reduce waste and inefficiency?

Tanya Tsui:

The focus has often been on closing loops using tools like digital building passports to track materials. While these tools are important, I think the broader goal should be material efficiency—using fewer materials while meeting the same needs. For instance, in the housing sector, building smaller homes or exploring co-housing models can significantly reduce material use. These approaches are more direct and impactful than solely focusing on recycling or reusing materials.

Nitisha:

Are there specific policies or tools you'd recommend to achieve this?

Tanya Tsui:

Currently, there aren't direct incentives for building smaller homes, though urban planning policies in the Netherlands do encourage efficient land use. Introducing frameworks, goals, or tax incentives specifically targeting reduced material use could be effective.

Nitisha:

Have you worked with or observed technologies like IoT, GIS mapping, or blockchain? Which do you think has had the most tangible impact?

Tanya Tsui:

My work focuses on GIS, which is a valuable research tool for mapping material flows and informing stakeholders. However, IoT and blockchain have more direct applications, often used by startups or companies to create products and services. GIS has an indirect impact, as it informs decisions rather than providing immediate solutions.

Nitisha:

Can you share a successful example of material flow optimization or industrial symbiosis?

Tanya Tsui:

In the construction industry, circular construction hubs are becoming more prominent. These hubs, often managed by demolition contractors, collect construction waste and find buyers for it. This practice is gaining traction in the Netherlands and demonstrates practical material flow optimization.

Cross-Border Collaboration

Nitisha:

What do you think is the most significant barrier to cross-border collaboration: policy misalignment, cultural differences, economic competition, or lack of communication? Could you share an example?

Tanya Tsui:

I'd rank lack of communication as the most significant barrier, followed by policy misalignment, cultural differences, and economic competition. In the construction industry, for example, loops are often localized, and cross-border collaboration is limited. Cultural differences also play a role, as the industry's conservative, network-driven nature creates barriers to collaboration beyond national borders.

Nitisha:

How can governance frameworks be improved to harmonize circular economy policies across Belgium, the Netherlands, and Germany?

Tanya Tsui:

There needs to be a shift away from the "local is better" mindset. Circular economy goals should prioritize material efficiency and emissions reduction over localization. For example, if importing recycled materials from another country is more sustainable than using local resources, that should be encouraged.

Nitisha:

How effective are EU-level institutions in bridging governance and policy gaps? What actions could make them more effective?

Tanya Tsui:

EU-level research funding is effective in fostering cross-border collaboration through projects that require consortiums. However, more could be done to ensure that research findings translate into actionable policies.

Stakeholder Engagement and Arenas

Nitisha:

Which factor is most critical to successful stakeholder collaboration: shared goals, trust and transparency, financial incentives, or effective communication?
Tanya Tsui:
Financial incentives are critical. Most collaborations are driven by mutual economic benefits, which incentivize stakeholders to work together.
Nitisha:
Do you think physical or digital stakeholder arenas are more effective?
Tanya Tsui:
Physical arenas are more effective for building trust and fostering collaboration. Digital arenas are great for information sharing, but physical interactions—like informal conversations at conferences—help establish deeper connections and trust.
Vision and Future Outlook
Nitisha:
How achievable is a fully circular Eurodelta by 2050? What milestones would be necessary to reach this vision?
Tanya Tsui:
A fully circular Eurodelta is unlikely and may not even be a desirable goal. Circular economy should be seen as a strategy to achieve broader sustainability objectives, such as reducing emissions and improving material efficiency. Key milestones include decoupling economic growth from emissions and improving material efficiency metrics, such as reducing the materials required per square meter of construction.
Nitisha:
How can the region leverage its strengths, like ports and industrial clusters, to become a circular economic hub?
Tanya Tsui:
Europe's strength lies in research and innovation. The challenge is to transfer this knowledge to regions where material use is growing rapidly, such as India and parts of Africa. The Eurodelta can position itself as a leader in circular economy research and knowledge-sharing.
Nitisha:
What emerging trends or technologies will drive circularity over the next decade?
Tanya Tsui:
Degrowth is an emerging concept worth exploring. Instead of focusing solely on consuming efficiently, we should consider reducing consumption altogether. This approach could be more effective in achieving sustainability goals.
Case Study Recommendations
Nitisha:
Could you share a case study or project that successfully advanced circular economy principles?
Tanya Tsui:
One example is Insert, a platform created by demolition contractors in the Netherlands to facilitate material exchange. Although still in its early stages, it demonstrates the potential for collaborative initiatives to improve material reuse.
Conclusion
Nitisha:
Do you have any additional insights or recommendations to strengthen my research?

Tanya Tsui:
Your questions were comprehensive and thought-provoking. I'd emphasize that circular economy is not an end goal but a strategy to achieve broader sustainability objectives. It's important to remain open to alternative approaches, especially in sectors where circular economy may not be the best strategy.
Nitisha:
Thank you so much for your time and insights. This has been incredibly helpful, and I'll send you the transcript for review. Would you be open to future collaboration as my thesis progresses?
Tanya Tsui:
Absolutely. Feel free to reach out if you need additional input. Good luck with your research!
Nitisha:
Thank you so much!
Refined Transcript 2

Section 1: Background and Expertise
Nitisha: Yes, okay. The first section is about expert background. What is your primary area of expertise? Is it circular economy, sustainable urban development, both equally, or any other?
Alexander Wandl: I am an urbanist, so my expertise is in sustainable spatial development. Circularity is a topic I am interested in, but my expertise lies in urbanism.
Nitisha: Okay. Could you share a key project or experience that exemplifies your expertise?
Alexander Wandl: Yes, I think the most significant one is the REPAiR project (Resource Management in Peri-Urban Areas), a Horizon 2020 project that finished in 2021. It was one of the first projects that connected flows and circularity to spatial planning, addressing questions of land, soil, and land use changes. That is a key project I can refer to.

Section 2: Project Scope and Cross-Border Collaboration
Nitisha: Have most of your projects been regional, national, or cross-border?
Alexander Wandl: Good question. Most of them focused on city-region or metropolitan scales, such as metropolitan cities and their peri-urban or rural surroundings. I've done some global-scale studies, for instance, examining the Port of Rotterdam's position in global flow exchanges and its impact on circularity in the Netherlands. While that had cross-border implications, the effects were understood nationally. The ASSET project is my first true cross-border and mega-regional collaboration.

Section 3: Circular Economy Challenges and Solutions
Nitisha: Now we move to the next section: circular economy in practice. Rank the following challenges in implementing circular economy principles from most significant to least significant: resource inefficiency, cost, technological gaps, and lack of stakeholder awareness.
Alexander Wandl: It depends on the scale. I think the top-ranked challenge is missing openness in data sharing among companies, which impacts resource exchange. Regulations that hinder collaboration and innovation are also a major challenge. Technological gaps are the least significant; technology is evolving and available. Lack of stakeholder awareness plays a role but is not the primary issue.
Nitisha: What would you suggest as a solution for data openness and regulatory challenges?
Alexander Wandl: One way to address data challenges is through product passports, which gather essential data for circularity. Digital twins are also valuable, especially in the built environment, to

understand material availability and quality. On the regulatory side, we need more experimental spaces—both physical and legislative—to test new ideas and frameworks.

Section 4: Material Flow Optimization

Nitisha: How can material flows in sectors like construction or agriculture be optimized to reduce waste and inefficiency? Are there specific policies or tools you recommend?

Alexander Wandl: In construction, policies like CO2 taxes and mandatory reuse through tendering processes could help. Spatial planning plays a significant role by providing the right types of spaces and infrastructures to facilitate material exchanges and experimentation. Land prices often limit these possibilities, but zoning can help regulate this.

For agriculture, we need to rethink the EU Common Agricultural Policy. Currently, most funding is geared toward food production. Shifting some of these schemes toward material production could create opportunities for bio-based materials while maintaining food security.

Section 5: Technology and Case Studies

Nitisha: Have you worked with or observed the use of technologies like IoT, blockchain, or GIS mapping? Which do you think has had the most tangible impact?

Alexander Wandl: I have worked with GIS mapping and observed blockchain applications. GIS is crucial because it adds spatial and quantitative dimensions to discussions. Blockchain is interesting in ecosystems like local currencies for businesses, as it offers context and independence. IoT relates to data availability but often requires more materials than it saves.

Nitisha: Can you share a successful example of material flow optimization or industrial symbiosis?

Alexander Wandl: The Superlocal office in Amsterdam is a great example. They produce furniture for hospitals using local materials, combining creativity, design, and social impact in environments with limited resources. It's a project that stands out.

Nitisha: What tools or datasets are most effective for tracking material flows?

Alexander Wandl: Unfortunately, waste datasets are the most commonly used. Logistic data and product codes, like those from customs or the EU's SPI material codes, are also helpful. These datasets, when connected, can model and understand material flows better.

Section 6: Cross-Border Collaboration

Nitisha: From your perspective, what is the most significant barrier to cross-border collaboration? Could you provide an example?

Alexander Wandl: Cultural and political differences, as well as policy misalignment, are significant barriers. For example, in the REPAiR project, we saw that some cities had open waste management markets, enabling cross-border activity, while others relied on local public services. This impacts efficiency and environmental consequences. Spatial planning policies, in particular, often lack alignment across borders.

Nitisha: How can governance frameworks be improved to harmonize circular economy policies across Belgium, the Netherlands, and NRW?

Alexander Wandl: We need a joint spatial strategy with financial backing and agreements on roles and responsibilities. A cohesive cross-border vision and strategy would prevent competition from undermining collaboration.

Section 7: Stakeholder Engagement
Nitisha: Which factors are most critical for successful stakeholder collaboration?
Alexander Wandl: Trust and transparency are essential. In the REPAiR project, for example, we developed a decision support system that made all proposals and decisions transparent, fostering collaboration.
Nitisha: Do you think physical or digital arenas are more effective?
Alexander Wandl: Both are needed, but I don't have a strong preference.
Nitisha: What incentives are most effective for engaging diverse stakeholders, especially smaller businesses?
Alexander Wandl: Frontrunners in circularity should not only share their knowledge but also grow together. Creating ecosystems where frontrunners can evolve collaboratively is crucial.

Section 8: Vision and Future Outlook
Nitisha: How achievable is a fully circular Eurodelta by 2050?
Alexander Wandl: Fully circular by 2050 is not achievable, mainly due to energy constraints. However, significant progress can be made in specific sectors like construction and biochemicals. By 2050, the circular economy should become the norm.
Nitisha: What milestones are necessary to achieve this vision?
Alexander Wandl: Significant regulatory changes, integration of spatial planning, and external pressures are needed. Spatial planning must take on a central role in organizing this shift.
Nitisha: How can the region leverage its unique strengths, like ports and industrial clusters, to become a circular economic hub?
Alexander Wandl: Beyond ports, the region's fertile soil and knowledge base are significant strengths. Strict environmental regulations, similar to those in the food sector, can support the circular economy.
Nitisha: What emerging trends or technologies will drive circularity over the next decade?
Alexander Wandl: Digitalization, AI, and advancements in basic material sciences, such as biochemistry and physics, will play critical roles.
Nitisha: Could you share a case study or project that exemplifies successful circular economy implementation?
Alexander Wandl: The city of Nokia in Finland, Brussels' initiatives, and Amsterdam's strategies are all excellent examples. South Holland's spatial circular strategy is also noteworthy.

Nitisha: Thank you so much for your insights. Do you have any additional recommendations for my research?
Alexander Wandl: The questions were broad, but I hope the interviews help you narrow your focus. Circularity often hinges on small, actionable details. Good luck, and feel free to share your findings.
Nitisha: Thank you! I will share my transcript and analysis with you soon. Have a great day.
Alexander Wandl: You too. Bye!

Refined Transcript 3

Section 1: Background and Expertise
Nitisha: Okay, perfect. So the first question is about your background. What is your primary area of expertise: circular economy, sustainable urban development, both equally, or something else?

Marianna Favers: I would say more in sustainable urban development and regional development.
Nitisha: Okay, could you share a key project or experience that exemplifies your expertise?
Marianna Favers: Yes, I do a lot of research, often what we call "design by research," using data. I can send you a link to a project I worked on a couple of years ago, where we mapped the development of the province of South Holland over the last 50 years, from 1970 to 2020. Using GIS, we analyzed how the province grew—where and how—and used that research to develop a new approach to urban development.
The findings showed that urban expansion primarily occurred in agricultural lands, and we proposed optimizing existing urban space instead of further expansion. This research led to creating a new framework for urban development in the province. We also made a story map to showcase the results, which I can share with you.
Nitisha: Yes, that would be really helpful.
Marianna Favers: Great. This project wasn't specifically about circular economy, but circularity is intertwined. For example, this new framework emphasizes reuse and recycling, aligning with circular economy principles. While I didn't directly work on the province's circular strategy, I'm familiar with it, and we often integrate those ideas into our work.

Section 2: Project Scope and Cross-Border Collaboration
Nitisha: That's great. Most of your projects seem regional, but have you also worked on national or cross-border initiatives? Could you share an example of a cross-border initiative and its impact?
Marianna Favers: Most of my work has been at the regional level within the province, but I've always sought opportunities for cross-border collaboration. Currently, I'm involved in the ASSET project, which is my first experience with such initiatives. Previously, I worked on projects that zoomed in and out of different scales, and I find it important to understand systems holistically.
However, cross-border collaboration is challenging due to political priorities and the complexity of working with diverse stakeholders. While it's not always a priority for the province, I personally believe it's crucial to address shared challenges.

Section 3: Circular Economy Challenges and Solutions
Nitisha: Understood. Moving on to circular economy in practice, could you rank the following challenges in implementing circular economy principles from most significant to least: resource inefficiency, cost, technology, and awareness?
Marianna Favers: All are important, but I'd rank costs as the most significant challenge. Many circular initiatives are more expensive than traditional ones, which creates a barrier. Awareness is also critical, but without cost feasibility, awareness alone doesn't lead to action. Technology is another area we're investing in, but it's not the main reason for slow adoption. Lastly, resource inefficiency is something companies already try to address, so I'd rank it lower.
Nitisha: So you see cost and space as the top challenges. Could you suggest ways to address them?
Marianna Favers: Yes, for space, we're developing policies to protect industrial parks for circular economy activities. For example, we're focusing on areas near rivers or canals to enable water-based transportation, which is vital for handling bulk materials. Protecting these areas often conflicts with housing needs, as municipalities may prefer converting industrial zones into residential spaces. However, safeguarding these spaces is crucial for scaling circular initiatives.

Section 4: Material Flow Optimization

Nitisha: That makes sense. How can material flows in sectors like construction or agriculture be optimized to reduce waste and resource inefficiency?

Marianna Favers: For construction, we're mapping material flows to create a system of hubs for processing and redistributing materials like concrete locally. Concrete, for instance, doesn't travel far, so having regional hubs is key. In agriculture, bio-based materials offer potential, but it's more complex as most land is dedicated to food and flowers. Convincing farmers to grow bio-based crops for materials like insulation is challenging and requires further exploration.

Nitisha: Are there specific policies or tools you recommend for optimization?

Marianna Favers: We use data analysis to identify critical locations for hubs and develop policies to protect those areas. GIS is a significant tool for us. We also rely on subsidies to encourage circular initiatives and make our data open for transparency and collaboration.

Section 5: Technology and Case Studies

Nitisha: Speaking of tools, have you worked with IoT, blockchain, or other technologies?

Marianna Favers: GIS is our primary tool. I'm not familiar with IoT or blockchain applications in our context. However, there is interest in exploring artificial intelligence for addressing challenges, though it's still in the early stages.

Nitisha: Could you share an example of successful material flow optimization or industrial symbiosis?

Marianna Favers: Dura Vermeer, a private company in South Holland, has a construction hub where they collect, reuse, and redistribute materials for their projects. It's a good example of optimizing material flows. I can share more details about this initiative.

Section 6: Governance and Policy Harmonization

Nitisha: Thank you. Moving to cross-border collaboration, what is the most significant barrier to such initiatives?

Marianna Favers: Cultural differences and varying priorities among regions. For example, in the ASSET project, we first had to establish common ground since each partner was at a different stage in the transition to a circular economy. This process is time-consuming but essential for effective collaboration.

Nitisha: How can governance frameworks be improved to facilitate harmonized circular economy policies across the region?

Marianna Favers: The EU sets a baseline, but its ambitions are often too low for our region. We need to set higher, localized ambitions and harmonize policies across the Eurodelta. Collaboration and shared goals within the region can accelerate progress.

Section 7: Stakeholder Engagement

Nitisha: Which factors are critical for successful stakeholder collaboration?

Marianna Favers: Shared goals are the most critical. In the ASSET project, for example, the shared goal of building more circular homes brought stakeholders together. Physical meetings are also essential for building trust and deeper connections.

Nitisha: What incentives work best for engaging diverse stakeholders?

Marianna Favers: Subsidies, circular procurement in tenders, and innovation incentives are effective. For smaller businesses, these incentives can make circular practices more viable.

Section 8: Future Prospects for Circular Economy
Nitisha: Do you think a fully circular Eurodelta by 2050 is achievable?
Marianna Favers: It's somewhat achievable, depending on how circularity is defined. Higher levels of circularity, like reuse and recycling at scale, will require significant effort and space. Defining clear goals and milestones for each material and industry is essential.
Nitisha: How can the region leverage its strengths, like ports and industrial clusters, to become a circular economic hub?
Marianna Favers: Better utilizing existing infrastructure is key. For instance, encouraging companies to locate near waterways can optimize transport and reduce reliance on trucks. Replacing low-value land uses in industrial parks with circular economy activities can also maximize productivity.
Nitisha: What emerging trends or technologies will drive circularity over the next decade?
Marianna Favers: Digitalization is crucial for tracking materials and optimizing flows. Open data and transparency will also be important to ensure equitable access to information.

Section 9: Final Insights and Recommendations
Nitisha: Could you share a case study or project that exemplifies successful circular economy implementation?
Marianna Favers: Our spatial circular strategy is a good example. It highlights the spatial impact of circular economy and led to policies protecting areas critical for circular activities. It's a pioneering study in integrating circularity into spatial planning.
Nitisha: Thank you so much for your insights.
Marianna Favers: You're welcome. Best of luck with your research, and feel free to share the transcript and results with me.

Refined Transcript 4
Introduction
Emma de Wijs:
Yes.
Nitisha:
Hello. My thesis focuses on stakeholder engagement and material flows in the Eurodelta region. It explores how to create a cross-border collaborative platform where circular economic principles can be implemented effectively. For this, I have five sections to discuss. I'll introduce each, and then there will be follow-up questions, including a few where you'll need to choose between options. This will help me gain insights into the current practices and perspectives. I'll also use this input to shape the interventions and strategies for my thesis. This interview will take about 45 minutes, and you can give either long or short answers—whatever feels right for you.
To start, could you tell me about your primary area of expertise? Is it circular economy, sustainable urban development, both, or something else?
Emma de Wijs:
My expertise lies in sustainable and urban development.

Nitisha:
Could you share a key project or experience that exemplifies your expertise?
Emma de Wijs:
Sure. One example is a project in the Eurodelta region, where I work for the city of The Hague. We aim to align the goals of the Eurodelta and EU with local initiatives. For instance, in the area development of Binckhorst, I assessed their sustainable and circular practices. While there were standalone initiatives, I realized the potential for scaling up these efforts to create broader impact rather than just focusing on isolated projects.
Nitisha:
Thank you. Have most of your projects been regional, national, or cross-border?
Emma de Wijs:
Most of my projects are cross-border within the Strategic Urban Region Eurodelta (SURE) network, which is a bottom-up collaboration among urban regions in the Rhine-Meuse Delta. We address shared challenges like fast rail connectivity and circular built environments. On an urban scale, I work on spatial issues, but I've recently shifted toward regional-scale projects focusing on sustainable, future-proof development in South Holland.
Circular Economy in Practice
Nitisha:
Great. Moving on to the circular economy, I'd like you to rank the following challenges in implementing circular economy principles, from 1 (most significant) to 4 (least significant):
Governance fragmentation
Lack of stakeholder awareness
Resource inefficiency
Technological gaps
Would you like me to list them in the chat for reference?
Emma de Wijs:
Yes, please.
Nitisha:
Done.
Emma de Wijs:
It's challenging to rank these because they are all interconnected, but I'd say lack of stakeholder awareness is the most significant issue. Governance fragmentation is a close second because organizations often fail to align on these issues. Resource inefficiency comes next, followed by technological gaps.
Nitisha:
Would you add any other major challenge?
Emma de Wijs:
Market development. Creating demand and supply for circular materials—both reused and bio-based—is crucial. There are often imbalances, and organizational challenges within supply chains make it harder to address this gap effectively.
Nitisha:
Could you elaborate on your top-ranked challenge and suggest ways to address it?
Emma de Wijs:

The lack of stakeholder awareness can be addressed through demonstrations of best practices and knowledge exchange. By showcasing successful projects, stakeholders can learn from real-world examples and build on that experience. For instance, setting up demonstration sites in South Holland could create a movement of stakeholders who are inspired and motivated to act.

Nitisha:

How can material flows in sectors like construction or agriculture be optimized to reduce waste and resource inefficiency?

Emma de Wijs:

Some private constructors create hubs where materials are reused, refurbished, or transformed into new products for other projects. This approach, often referred to as "from land to building to plan," emphasizes efficiency by connecting material production and reuse in close proximity to construction sites. For example, wood is assessed for quality, treated, and reused for new structures. Efficiently organizing this chain and locating hubs close to urban centers can significantly reduce waste and inefficiency.

Nitisha:

Are there any specific policies or tools you recommend for achieving this?

Emma de Wijs:

Policies should set higher standards and stretch goals beyond current norms. For example, the EU Green Deal and Taxonomy Framework require businesses to report on their environmental impacts, but local governments could push further by demanding stricter compliance. Additionally, governments should prioritize sustainable practices when collaborating with enterprises and allocate space for circular hubs in urban plans.

Nitisha:

Have you worked with or observed the use of technologies like IoT, GIS mapping, or blockchain?

Emma de Wijs:

Yes, we've used GIS for spatial planning and analyzing locations for circular hubs. This tool helps align policy ambitions with tangible plans by identifying the best locations for circular initiatives. However, further development is needed to translate policy goals into actionable spatial strategies.

Cross-Border Collaboration

Nitisha:

From your perspective, what is the most significant barrier to cross-border collaboration? Is it policy misalignment, cultural differences, economic competition, or lack of communication?

Emma de Wijs:

Economic competition is a major barrier. For example, during a study tour in Duisburg, we observed how reused steel was exported to Turkey because it was cheaper than using it locally. This highlights how global economic dynamics can undermine local circular economy efforts. Policy misalignment is another challenge, as different regions are at varying stages of implementing circular economy principles. Cultural differences and governance styles also play a role—for instance, the Netherlands has a more informal approach compared to Germany's hierarchical system. Lastly, while communication around projects is generally effective, it often requires significant effort, particularly for cross-border initiatives.

Nitisha:

How can governance frameworks be improved to harmonize circular economy policies across the Eurodelta region?

Emma de Wijs:

The EU Taxonomy Framework is a good starting point, but it needs broader adoption and integration into national and regional policies. Multi-level governance is essential for aligning efforts between nations, regions, and cities. The Eurodelta network's roadmap emphasizes phased development, but formalizing governance structures could help overcome bottlenecks and ensure better coordination.

Nitisha:

How effective are EU-level institutions in bridging governance and policy gaps?

Emma de Wijs:

Moderately effective. While the EU Green Deal was a promising initiative, its impact has been diluted due to political challenges. To improve effectiveness, the EU could provide clearer instructions, tools, and policies that regions can adapt to their specific needs. Facilitating multi-level collaboration rather than enforcing a top-down approach would enhance its impact.

Stakeholder Engagement and Arenas

Nitisha:

Which factor is most critical to successful stakeholder collaboration: shared goals, trust and transparency, financial incentives, or effective communication? Could you provide an example where this factor was particularly influential?

Emma de Wijs:

Shared goals are crucial. For instance, South Holland's circular strategy involved creating area-specific stakeholder arenas to align goals. This collaborative approach fostered cooperation around a common vision for circular development. Trust and transparency are also vital for sustaining long-term partnerships.

Nitisha:

Do you think physical or digital stakeholder arenas are more effective?

Emma de Wijs:

Both are necessary and complement each other. Physical arenas allow for direct interaction and a better sense of collaboration, while digital arenas enable broader participation and visualization through tools like videos or maps.

Nitisha:

What design features or practices foster effective participation in stakeholder arenas?

Emma de Wijs:

Study tours and site visits are highly effective. For example, in South Holland, stakeholders visited key locations to understand challenges and opportunities firsthand. This method enhances engagement by fostering discussions based on real-world observations.

Vision and Future Outlook

Nitisha:

How achievable is a fully circular Eurodelta by 2050? What key milestones are needed?

Emma de Wijs:

It's somewhat achievable but requires significant effort. Key milestones include scaling up circular housing initiatives, securing national government support, and fostering collaboration across regions. For example, the Dutch government's upcoming "Nota Ruimte" policy document may provide direction for achieving circularity goals.

Nitisha:

How can the region leverage its unique strengths, like ports and industrial clusters, to become a circular economic hub?

Emma de Wijs:
Ports are crucial for facilitating material flows and logistics. By optimizing transport routes and integrating circular hubs, ports like Rotterdam can support the transition to circularity. Additionally, hinterland ports play a vital role in connecting urban centers with regional supply chains.
Nitisha:
What emerging trends or technologies will drive circularity in the next decade?
Emma de Wijs:
Behavioral shifts towards consuming less and reusing more will be critical. Adaptive reuse of buildings, for instance, could replace the current practice of demolishing and rebuilding. Encouraging these practices through policy and awareness campaigns will be key.
Case Study Recommendations
Nitisha:
Can you share a case study or intervention that successfully advanced the circular economy in the Eurodelta or elsewhere?
Emma de Wijs:
One example is the Floriade event in Almere, which showcased sustainable urban practices. While expensive, it demonstrated innovative solutions that could inspire other regions. Another example is a Brussels-based business that recycles earth from construction sites to create new building materials. Such initiatives could be scaled across the Eurodelta.
Conclusion
Nitisha:
Do you have any additional insights or recommendations for my research?
Emma de Wijs:
You've covered everything well. I can share the Eurodelta roadmap if it would help. Best of luck with your research—I'm curious to see how it develops!
Nitisha:
Thank you so much for your time and valuable insights. I'll send you the transcript for review. Have a great day!
Emma de Wijs:
Thank you, and good luck!
Refined Transcript 5
Introduction
Nitisha:
Thank you for participating in this interview. To start, could you tell me about your expert background? Is your primary area of expertise in circular economy, sustainable urban development, or something else?
Bart Bomas:
I work at an advisory office in the Netherlands, focusing on spatial questions related to urban and landscape development. My profession is landscape architecture, so I'm a landscape architect. I mainly work on urban and regional development. While I'm not an economist, I'm familiar with circular economy principles, but my primary focus is on the spatial aspects.
Nitisha:
Could you share a key project or experience that exemplifies your expertise?
Bart Bomas:

I've worked on the development of an area near the Feyenoord stadium in Rotterdam. It's a large urban development project with housing, sports programs, and park development—a very integrated urban development. I've also worked on a vision for the future of the Province of Utrecht, focusing on landscape and spatial decisions for 2050. So, my work spans both large- and small-scale projects.

Nitisha:

Have most of your projects been regional, national, or cross-border? Could you provide an example of a cross-border initiative and its impact?

Bart Bomas:

Most of my work is at the urban or regional scale. I've worked on some cross-border projects, such as in the southern part of the Province of Zeeland, near Flanders. There's a cross-border area called the Ghent-Terneuzen Canal Zone, which has economic, urban, and social connections. I've been involved in envisioning the future of this area, focusing on economic development while creating a livable and sustainable environment.

Circular Economy in Practice

Nitisha:

Let's move to circular economy in practice. Could you rank the following challenges in implementing circular economy principles from 1 (most significant) to 4 (least significant): governance fragmentation, lack of stakeholder awareness, resource inefficiency, and technological gaps?

Bart Bomas:

I'd rank governance fragmentation as the biggest challenge. Many companies struggle with complex regulations, making collaboration difficult. Resource inefficiency would come second because we'll face shortages in the coming years, which will drive the need for circular economy practices. I'd rank stakeholder awareness third—it's crucial to engage stakeholders and change behaviors. Finally, technological gaps would be the least significant, as there are many technologies already available.

Nitisha:

Could you elaborate on governance fragmentation and suggest ways to address it?

Bart Bomas:

Governance fragmentation is a challenge, especially in the Netherlands, which has many regulations and must also align with EU policies. Cross-border collaboration adds complexity due to differing tax systems and regulations. To address this, we need governance structures tailored to specific scales. This starts with envisioning and showcasing successful pilot projects that demonstrate the benefits of circular economy. Governments can then build on these examples to develop the necessary structures.

Nitisha:

How can material flows in sectors like construction or agriculture be optimized to reduce waste and inefficiency?

Bart Bomas:

In the built environment, concrete and steel are the main materials with high ecological and carbon footprints. Transitioning to bio-based materials and scaling up recycling efforts for steel and concrete are essential. For example, keeping steel within Europe for recycling instead of exporting it would be more sustainable. We also need logistical systems to optimize the locations of recycling hubs and integrate them into urban networks. Agricultural areas in the Eurodelta can be repurposed to grow bio-based fibers, while wood from other parts of Europe can supplement the construction industry.

Nitisha:

Are there specific policies or tools you'd recommend to achieve this?
Bart Bomas:
True pricing would help, ensuring that materials with larger footprints, like concrete, reflect their environmental costs. Design tools, such as urban and landscape design, can also help visualize and strategize material flows and spatial impacts.
Nitisha:
Have you worked with technologies like IoT, GIS mapping, or blockchain? Which has had the most tangible impact?
Bart Bomas:
GIS is a core tool for our design tasks. It's useful for analyzing and optimizing circular systems, but data availability and consistency across countries remain challenges. Blockchain could be valuable for verifying material origins and ensuring transparency in supply chains. In terms of impact, GIS is critical for planning and optimizing material flows.
Nitisha:
Can you share a successful example of material flow optimization or industrial symbiosis?
Bart Bomas:
Industrial symbiosis is challenging but possible at larger scales, such as in the Rotterdam Harbor, where industries exchange material flows. Smaller-scale examples are more common, like in Brussels, where stone-making industries share resources and equipment within the region.
Cross-Border Collaboration
Nitisha:
What is the most significant barrier to cross-border collaboration: policy misalignment, cultural differences, economic competition, or lack of communication? Could you share an example?
Bart Bomas:
Policy misalignment is the biggest barrier when scaling up collaborations, while cultural differences also play a role. For example, Dutch professionals excel at envisioning innovative solutions, but German counterparts prefer structured, hierarchical approaches, which can slow collaboration. Economic competition mainly affects larger industries like steel, but it's less significant for smaller initiatives.
Nitisha:
How can governance frameworks be improved to harmonize circular economy policies across Belgium, the Netherlands, and Germany?
Bart Bomas:The Eurodelta doesn't have a formal political structure, so collaboration must start bottom-up, with cities and regions working together. Networks like Benelux or EU platforms can eventually scale up successful examples to a political level. Private networks of businesses already collaborate across borders and could benefit from formal governance support to strengthen these relationships.
Nitisha:How effective are EU-level institutions in bridging governance and policy gaps? What could make them more effective?
Bart Bomas:EU institutions are moderately effective, particularly through regulations like the EU Taxonomy, which sets goals and accelerates the green economy. However, the real work happens on the ground, so stronger support for bottom-up initiatives and practical implementation is needed.
Stakeholder Engagement and Arenas
Nitisha:Which factor is most critical to successful stakeholder collaboration: shared goals, trust and transparency, financial incentives, or effective communication?

Bart Bomas:Trust and transparency are crucial, especially in circular economies, where interdependencies between businesses are higher than in linear systems. For example, in Brussels, trust between startups and larger companies enabled them to secure a shared space for circular activities.
Nitisha:Do you think physical or digital stakeholder arenas are more effective?
Bart Bomas:Physical arenas are better for fostering understanding and collaboration, while digital arenas are more efficient for sharing information and engaging larger audiences. A combination of both works best.
Nitisha:What design features or practices foster effective participation?
Bart Bomas:Maps and visualizations are essential for communicating complex ideas to diverse stakeholders. Scenario planning helps show different outcomes and choices, making it easier for stakeholders to engage and contribute.
Nitisha:What incentives are effective for engaging diverse stakeholders, especially smaller businesses and communities?
Bart Bomas:Smaller businesses need tangible benefits, such as improved positioning, cost savings, or logistical support. Translating long-term goals into immediate actions can also help them see the value of participation.
Vision and Future Outlook
Nitisha:How achievable is a fully circular Eurodelta by 2050? What key milestones are needed?
Bart Bomas:A fully circular Eurodelta by 2050 is ambitious. Some sectors, like steel and concrete, will likely transform faster due to economic pressures and regulations. Key milestones include reducing material streams, redesigning products for efficiency, and scaling up recycling initiatives. Transition speeds will vary by industry.
Nitisha:How can the region leverage its strengths, like ports and industrial clusters, to become a circular economic hub?
Bart Bomas:The Eurodelta's dense infrastructure, waterways, and logistical networks are key strengths. Corridors like Rotterdam to the Ruhr region and Amsterdam to Paris can anchor circular activities. Building a system of logistical hubs and transforming existing industries into green industries will be critical.
Nitisha:What emerging trends or technologies will drive circularity over the next decade?
Bart Bomas:Digital tools like AI and GIS will optimize systems, while the transition to healthier, greener cities will redefine urban and landscape planning. Circular economies require systemic changes, including shifts in behavior and consumption patterns.
Case Study Recommendations
Nitisha:Could you recommend a case study or project that successfully advanced circular economy principles?
Bart Bomas:Amsterdam is leading with its circular city vision and programs. Brussels also has strong initiatives, particularly in logistics and the built environment. In Limburg, near Aachen, there are innovative practices connecting landscapes, businesses, and communities, which could serve as valuable examples.
Conclusion
Nitisha:Do you have additional insights or recommendations to strengthen my research? Were the questions comprehensive?
Bart Bomas:Your questions were well-structured. I'd recommend looking into recent work by Joanne Williams on the regional scale as a key factor for circular economy. Her new book addresses this topic and could be a useful resource.

Nitisha:Thank you for your time and insights. I'll send you the transcript for review and follow up if needed. Would you be open to future collaboration?
Bart Bomas:Of course. Feel free to reach out if you need further input. Good luck with your research!
Nitisha:Thank you so much!