WATER BOARDS NAVIGATING THE TRANSITION TOWARDS CIRCULAR USE OF DREDGED SEDIMENT

JOSEPHINE LOUDON

STUDENT IDS:

5663512 & S3012573

INDUSTRIAL ECOLOGY

TU DELFT

LEIDEN UNIVERSITY

HET CIRCULAIRE BAGGER CONSORTIUM

TU Delft
Delft University of Technology

Universiteit Leiden

FIRST SUPERVISOR: DR. IR. U. PESCH, TU DELFT, ETHICS/PHILOSOPHY OF TECHNOLOGY

SECOND SUPERVISOR: DR. IR. J. QUIST, TU DELFT, ENERGY AND INDUSTRY

CBC SUPERVISOR: BOUKJE VASTBINDER, MSC

Cover Photo

Title:	*"Climate-Adaptive Parking"*
Photography:	*Waterweg*
Source:	*Waterweg, www.waterweg.co*
Description:	*This image depicts the first test of dredged sediment paving for a climate-adaptive parking spot at Hoogheemraadschap Schieland en de Krimpenerwaard's headquarters, exemplifying Waterweg's commitment to circular use of dredged material.*

Water boards navigating the transition towards circular use of dredged sediment

Master thesis submitted to
Delft University of Technology and Leiden University in partial fulfilment of the requirements for the degree of

MASTER OF SCIENCE

in Industrial Ecology

Faculty of Technology, Policy and Management (TPM) Faculty of Science,
Institute of Environmental Sciences (CML) by

Joséphine Loudon

Student IDs: 5663512 and s3012573

To be defended in public on January 25th, 2024

First Supervisor:	dr. ir. U. Pesch, TU Delft, Ethics/Philosophy of Technology
Second Supervisor:	dr. ir. J. Quist, TU Delft, Energy and Industry
CBC Supervisor:	Boukje Vastbinder, MSc

EXECUTIVE SUMMARY

This research critically examines Dutch water boards' journey towards the circular use of dredged sediment, set against the backdrop of water boards' ambitious targets for circularity. Water boards, carrying the majority of responsibility for regional dredging, must navigate the surplus of approximately 40 million cubic meters of dredged material annually, with the declining availability of disposal permits. This has made the pursuit of circular solutions essential. Despite the central role of water boards in managing dredged material, particularly in freshwater contexts, there has been a lack of empirical study on how these actors are navigating and shaping the transition towards the repurposing of this material. As they confront this challenge, Dutch water authorities have set bold targets, aligning with national circularity goals: achieving 50% circularity by 2030 and reaching 100% by 2050.

Understanding the discursive practices of water board actors is crucial to comprehend the complexities of this transition. The urgency for a circular transition is clear, yet the specific path to achieving these targets remains a multifaceted puzzle. This study aims to shed light on the processes and practices involved. Accordingly, it as proposes the following research question:

How do water boards navigate and shape the transition towards circular use of dredged sediment?

Its main findings are structured according to the three sub-research questions that organize the results sections. These questions are anchored in the conceptual lens of sustainability transitions and discursive institutionalism, as proposed by Genus (2014):

1. *What are the fundamental norms and regulations that define the operational landscape of the dredging ecosystem in the context of Dutch water boards?*
2. *What patterns are evident in the discourse within water boards as they shift towards the circular use of dredged materials?*
3. *To what extent are regulative, normative, and cultural-cognitive rules related to the circular use of dredged material institutionalized within the operations of water boards?*

Prior to delving into the research, the research establishes a foundational understanding of key concepts. These concepts serve as essential lenses through for the analysis. The paper explores concepts such as circular economy, sustainability transitions and agency. Against this background, the study places special emphasis on a discourse-institutionalist approach to examine sustainability transitions. This approach emphasizes the role of language, narratives, and discourses in shaping institutional practices and policies. It acknowledges that the transition to sustainable and circular practices is not just a technical or economic challenge but also a discursive one, involving shifts in values, norms, and societal narratives, and the role of institutional actors in environmental transitions.

The study subsequently employs qualitative methodologies to explore the dynamic interactions within water boards as they confront the challenge of transitioning to circular practices. Focusing on the Circular Dredging Consortium (Ciculaire Bagger Consortium - CBC), the research dissects the mutual efforts of key water boards, namely *Hoogheemraadschap Schieland en de Krimpenerwaard*, *Waterschap Hollandse Delta*, and *Hoogheemraadschap Rijnland*. These entities are instrumental in

pioneering the circular use of dredged material. By analyzing, relevant literature, the water boards' policy documents, conducting interviews, and engaging in participant observation, the research reviews the nuanced discourse and actions of water board actors. It uncovers how they navigate, influence, and shape the complexities of adopting circular practices, thereby shedding light on the interplay between established procedures and innovative approaches within the sector. The research unfolds the complexities of the Dutch water boards' transition to circularity through a series of results chapters.

The first results chapter explores the fundamental norms and regulations that define the operational landscape of the dredging ecosystem in the Netherlands, with a particular focus on the role of water boards. It highlights the complex, regulatory environment and the inherent conservatism of the dredging sector that favors proven methods over innovation. This sets a foundation for understanding the water boards' decision-making processes and their cautious approach to adopting new practices.

Building on the established context of the dredging industry's conservatism, the second results chapter examines what patterns are evident in the discourse of water boards transitioning towards circular use of dredged material. It reveals a tension between the traditional "rules of the game" and new circular practices. While there is a recognized need for transitioning to circularity, there are significant internal and external challenges to overcome, indicating a complex path ahead for the implementation of circular principles.

The final chapter ties together the insights from the previous chapters by analyzing the degree to which the emergent narratives and practices around circularity are becoming institutionalized within water boards' operations. It discusses the gradual change in regulative, normative, and cultural-cognitive rules towards circularity, despite the enduring caution and risk-averse nature of the industry. The chapter concludes that while there is movement towards innovation, the transition is tempered by the weight of established practices, showing an industry at the crossroads between tradition and innovation.

In synthesizing these results, the study determines that Dutch water boards are at a crucial juncture, attempting to overcome traditional practices' inertia and integrate circularity into their dredging operations. The journey towards institutional change is marked by cautious steps, with visible progress tempered by regulatory rigidity, risk aversion, and the lack of a unified approach to circularity. The slow pace of change suggests that achieving the ambitious circularity targets by 2030 and 2050 will be challenging. The research highlights the broader implications for environmental governance and the pursuit of sustainability within intricate institutional frameworks. It underscores the resilience required and the imperative for adaptable innovations to reform deeply embedded systems.

Finally, the discussion encapsulates the complex interplay between institutional dynamics and individual agency in the transition towards sustainable practices. Reflecting on the findings, practical recommendations suggest a systemic and strategic transformation approach, recommending the establishment of a mission agency within water boards to centralize and drive the transition. Such a mission agency recognizes the need for both top-down and bottom-up reformations, highlighting that environmental governance necessitates a transformation of not only policies and technologies but also of institutional norms and individual mindsets.

ACKNOWLEDGEMENTS

I am deeply grateful for the completion of this thesis, which underscores the significance of dedicated efforts and necessary changes amidst ongoing sustainability transitions. Firstly, I want to express my gratitude to Eva Aarts, who has been more than a close friend – she has been a profound source of inspiration. Her commitment to advancing circularity in the dredging industry has reshaped my perspective on sustainability in many ways. Her tireless passion for sustainability has made a lasting impact on me. She generously connected me to key individuals and groups in her network, which was invaluable to my research. Beyond her professional influence, my friendship with Eva is a constant source of joy and support. Additionally, special thanks go to the other members of the CBC (Het Circulaire Bagger Consortium), and in particular to all the water board members who shared their time and insights with me through interviews. Your contributions were essential to the completion of my research. My thanks also to Boukje Vastbinder of the CBC, for welcoming me into the group immediately, seeking my input, and providing me with constructive advice, which greatly contributed to my research experience.

Furthermore, I want to express my appreciation to my TU Delft supervisors, Udo Pesch and Jaco Quist. Their support and expert guidance have been instrumental throughout my research process. Their knowledge and insights were critical in navigating the complexities of my research topic. Lastly, I must acknowledge the continuous support of my friends and family. Their constant encouragement and practical help have been pillars of encouragement, offering stability and motivation through the more challenging times.

This research concludes with a grounded yet optimistic perspective on the transition towards a more circular use of dredged material. Despite the findings that innovation within water boards may be a lengthy journey, hindered by structural rigidity and a pull towards the status quo, there remains a tangible motivation among the people I have engaged with during my research period. Throughout this process, I have been struck by the underlying determination of water board professionals to explore new horizons, even as they grapple with the complexities of shifting away from traditional practices. There is a clear recognition that dredged materials need not be seen as waste but as valuable resources that can be repurposed, signaling a shift in perception towards resource management.

My hope is that this thesis will contribute, even if only slightly, to the ongoing dialogue on sustainability and circularity and act as a push for future developments in the field. By examining the role of water boards in the move towards circularity, the study adds to our understanding of the nuanced interplay between desire for change and the inertia of 'business as usual.' I am confident that the commitment and curiosity for sustainable innovation that I witnessed among water board professionals, despite the pull of conventional methods, have the potential to inspire and motivate other sectors to pursue transitions towards a more just and sustainable future.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

CBC: *Circuliare Bagger Consortium (Circular Dredging Consortium)*
CE: *Circular Economy*
GWW: *Grond-, Weg- en Waterbouw (Ground, Road, Water Construction)*
HREC: *Human Research Ethics Committee*
STOWA: *Stichting Toegepast Onderzoek Waterbeheer (Foundation for Applied Water Management Research)*

1. INTRODUCTION

Dredging, a pivotal process involving the removal of silt, sediment, and debris from the bed of water bodies like lakes, rivers, harbors, and oceans, holds significance in maintaining the equilibrium between water and sediment (Arreola et al., 2022; Sittoni et al., 2019). This practice, often carried out in underwater or partially submerged regions of shallow waters, plays a fundamental role in safeguarding against flooding and ensuring the navigability of waterways and harbors (Collier et al., 2014; Paipai, 2003). The Netherlands, much like other delta regions, copes with a multitude of challenges stemming from rising sea levels, land subsidence, altered natural sediment flow, and human-induced changes in sediment distribution. In response, a deliberate and strategic approach to sediment management has become imperative (Ministerie van Infrastructuur en Waterstaat, 2023b).

While Rijkswaterstaat plays a central role in maintaining specific national waterways, the duty of dredging in regional waterways is allocated to various local and regional government entities. Provinces, municipalities, and regional water boards collectively bear the responsibility for dredging maintenance in waterways that fall outside the direct jurisdiction of Rijkswaterstaat. This decentralized strategy guarantees a coordinated and all-encompassing approach to safeguarding the Netherlands' water infrastructure (Ministerie van Infrastructuur en Waterstaat, 2023b; “Waterbodembeleid en baggeren,” n.d.). Compared to municipalities and provinces, water boards bear the largest responsibility for conducting regional dredging activities. Moreover, they frequently oversee the outsourcing of dredging tasks that would typically be managed by municipalities and provinces (*Baggerproblematiek in Nederland*, 2009).

The Netherlands' water authorities are now facing a pressing issue: the sustainable management of dredged material. They grapple with an annual surplus of around 40 million cubic meters of dredged material and a decreasing number of permits for disposal, prompting them to seek circular solutions[1]. This circumstance offers a distinctive chance for excess dredged material to transition from being a logistical challenge to becoming a valuable resource. Additionally, the Dutch government also addresses the continuous requirements for construction materials, land elevation, and coastal defenses. Notably, sand and clay, extracted from the environment, serve as primary resources for these requirements (van der Meulen et al., 2007). Here, the government has identified that efficient repurposing of sediment has the potential to substantially decrease the need for primary resources. To address this, the Dutch government has initiated efforts to repurpose dredged sediment (Besseling et al., 2020; Brils et al., 2014).

Against this background, this research focuses on water boards in transition towards dredging activities that are becoming more circular. To understand the complexities of this transition and acquire empirical insights, a detailed investigation into the discursive practices employed by water board actors is significant. Drawing from real-world practices and experiences, this empirical study contributes to a broader and more in-depth understanding of how local governance can shape transitions in resource management, particularly in the context of circular use of dredged material.

[1] The precise volume of excess dredged material remains a topic of discussion. A contributing factor to this uncertainty is the absence of a standardized national tool for measuring dredged material in the Netherlands. The figure of 40 cubic meters originates from the CBC database and was estimated using a variety of sources that track dredged material volumes.

The water boards, particularly *Hoogheemraadschap Schieland en de Krimpenerwaard*, *Waterschap Hollandse Delta,* and *Hoogheemraadschap Rijnland*, serve as a particularly compelling case study due to their participation and financial contributions to a collaborative endeavor aimed at transforming the dredging industry: The Circular Dredging Consortium (Circulaire Bagger Consortium (CBC)).

The CBC promotes the active development of a circular ecosystem for construction with dredged material. This ecosystem is poised to revolutionize the management of excess dredged material, minimize waste, mitigate carbon emissions, and foster the use of dredged material as a valuable resource while embracing circular construction materials. CBC was initiated by *Waterweg, a* pioneering venture in the development of climate-adaptive paving using dredged material; *Blauwe Bagger,* which specializes in the separation and utilization of dredged sludge; and *Noorderwind*, which guides innovation processes in the impact-driven economic landscape (*Hét Circulaire Bagger Consortium*, n.d.).

Water boards occupy a crucial position at the very beginning of the dredging supply chain, acting as the primary providers of dredged material. Given this foundational role, their active participation in transitions towards more circular utilization of dredged materials is key. The water boards' involvement is especially significant in decision-making processes. By setting the initial conditions under which dredging occurs, water boards shape the potential for circular use of dredged sediment. Therefore, understanding the dynamics in this transition within water boards is critical for the successful transformation of the dredging industry into circular landscape.

1.1. WATER BOARDS, DREDGING AND CIRCULARITY

Water boards, the oldest governing bodies in the Netherlands, have a rich history dating back to their origins in the necessity for farmers in a single polder to collaborate to manage water levels. Over time, these collaborations evolved into systems where farmers contributed proportionally to their land ownership, which also determined their influence within the water board. Thus, water boards were originally conceived as a means to address shared challenges within a region (Breeman et al., 2012). The first water board, *Hoogheemraadschap Rijnland*, was established by Count Willem II in 1255 and is still active today. In 1920, there were approximately 2,500 official water boards, but today this number has been reduced to twenty-one. In 1927, all water boards united in the *Unie van Waterschappen* (Union of Water Boards), an overarching body that advocates for the interests of water boards, promotes knowledge exchange, and fosters cooperation among them (Unie van Waterschappen, 2023).

Dutch water authorities are aligned with the national objectives to attain 50% circularity by 2030 and 100% by 2050. Nevertheless, a detailed strategic plan to achieve these benchmarks is still undeveloped (Besseling et al., 2020). The Netherlands' geographically vulnerable position and extensive network of waterways underscore the need for sustainable water management. Water boards, as key stakeholders in this process, face the complex task of integrating circularity into their practices. Achieving this transition holds the potential to address several pressing societal and environmental challenges.

Yet, while the urgency of a circular transition is clear, with regards to water boards, dredging and circularity, there remains a large gap in existing literature – although one research stands out in this regard. STOWA (Stichting Toegepast Onderzoek Waterbeheer) i.e. the Foundation for Applied Water Research, is a Dutch organization dedicated to applied research and innovation in the field of water management. In 2020, STOWA undertook a research initiative focusing on the circularity aspect of dredging operations, leading to the creation of a specialized assessment tool named "CircSed." This tool was designed to quantitatively measure the circularity of dredged material management in regional projects (Besseling et al., 2019). However, this research remains focused on a methodology to measure circularity, but lacks an insight into what is necessary to set in motion an institutional transition.

Such a transition process was nevertheless investigated in a recent research on the transition to circular ground, road, and water infrastructure. This study found that the ground, road, and water construction (GWW) sector in the Netherlands, among which water boards were part of the research subjects, faces challenges in transitioning to circularity due to its project-driven nature, diverse ambitions, and a lack of measurable circularity metrics. They state that public commissioning authorities play a pivotal role in driving this transition but are underutilized. Whilst urgent circularity goals have been set, there's a need for clearer focus and better measurement. Some recycling practices exist, yet higher-value circular strategies encounter barriers like knowledge sharing, procurement challenges, and limited scaling. The research maintains that to achieve circularity, changes in mindset and procurement practices are essential (Bours et al., 2022).

Building on these findings, it becomes evident that water boards are not only fundamental to the sector but are also central to the management and stewardship of natural resources. Given their influence and the complexities inherent in their operations, water boards are key subjects for examining how circularity can be embedded within institutional practices. This research acknowledges the pivotal role that water boards have as public commissioning authorities and seeks to delve deeper into whether and how they leverage their position to catalyze a transition to circular use of dredged sediment.

In light of the set urgency for circularity goals and the recognized necessity for clearer focus and improved metrics, the examination of water boards' transition processes offers a microcosmic view of the broader challenges and opportunities within the GWW sector. By investigating the intricacies of water boards' approaches to circularity, this study aims to contribute to the growing body of knowledge on sustainable practices within vital institutional infrastructure sectors. It also seeks to provide evidence-based recommendations that can inform policy-making and operational adjustments necessary for achieving higher-value circular strategies, thus helping to overcome the current barriers to a sustainable future (Besseling et al., 2019).

1.2. PROBLEM STATEMENT

The transition towards a circular economy in the management of dredged sediment poses a complex challenge, particularly within the operational and policy frameworks of regional water boards in the Netherlands. While existing literature provides insights into the technical and ecological aspects of repurposing dredged material (Arreola et al., 2022; Bilgen & Altuntas, 2023; Crocetti et al., 2022;

Heise et al., 2020; Radjenovic et al., 2023), it often overlooks the intricate role that water boards play in this process. These entities, pivotal in regional freshwater sediment management, are not only implementers but also shapers of the transition, holding significant influence on regulatory, strategic, and practical facets of circular resource use. This research seeks to bridge the empirical gap by examining the attitudes, narratives, and actions of water board actors as they navigate the path towards circular use of dredged sediment. It critically analyzes the institutional discourse, the challenges of entrenched practices, and the opportunities for innovation within these regional governmental bodies. By doing so, the study aims to unravel the layers of complexity in institutionalizing circularity, contributing to a deeper understanding of how sustainable practices can be embedded within the governance structures that significantly influence the landscape of resource management.

1.3. RESEARCH QUESTIONS

Against the background of the problem statement the following research question guides this study:

How do water boards navigate and shape the transition towards circular use of dredged sediment?

To be able to answer the main research question, this research proposes three sub-questions. These questions are anchored in the conceptual lens of sustainability transitions and discursive institutionalism, as proposed by Genus (2014) – the next chapter elaborates on these concepts. The following sub-question guide this research:

1. *What are the fundamental norms and regulations that define the operational landscape of the dredging ecosystem in the context of Dutch water boards?*

2. *What patterns are evident in the discourse within water boards as they shift towards the circular use of dredged materials?*

3. *To what extent are regulative, normative, and cultural-cognitive rules related to the circular use of dredged material institutionalized within the operations of water boards?*

1.4. SOCIETAL RELEVANCE

The societal relevance of this research relates to the interplay between environmental sustainability, infrastructure development, and governmental policies. At its core, this study addresses the urgent need for sustainable resource management, contributing to environmental resilience by supporting circular practices and minimizing disruption to delicate ecosystems (Ali et al., 2019). By highlighting the role that local government actors play in sediment repurposing efforts, the research offers insights into reducing the environmental impact that is caused by primary resource extraction (Bianchi & Cordella, 2023). Moreover, the examination of government practices may yield insights into policy innovation and governance dynamics, enhancing the understanding of how government

interventions can influence broader societal benefits by promoting sustainable resource utilization (Popescu et al., 2022; Uyarra et al., 2020).

1.5. ACADEMIC RELEVANCE

The significance of institutions in the sustainability transitions narrative is central to this research. Institutions embrace a range of factors, including policies, laws, norms, and decision-making processes, all of which significantly influence the adoption and implementation of sustainable practices (Brown et al., 2013; Fuenfschilling & Truffer, 2016). Despite the significance of institutions, their role in facilitating or obstructing sustainability transitions is often underexplored in research (Bosman, 2022). This gap has presented an opportunity for this study to contribute valuable insights into the institutional dynamics at play in the context of institutions in transition to sustainable practices, i.e. water boards transitioning towards circular use of dredged sediment.

In challenging the existing paradigms, this study adopts a theoretical framework from Genus (2014, 2016) that extends beyond the conventional Multi-Level Perspective (MLP) utilized in analyzing sustainability transitions. The MLP is a well-known framework that analyzes transitions as interactions between developments at three levels: niches (the place for radical innovations), regimes (the dominant practices and rules), and landscapes (the broader external environment) (Geels, 2019). This model has been criticized for not sufficiently accounting for the role of agency, meaning the actions of individuals and groups, in shaping transitions (de Haan & Rotmans, 2018; Farla et al., 2012; Fischer & Newig, 2016; Pesch, 2015; Scholz & Binder, 2011; Wittmayer et al., 2017). Genus (2014, 2016) integrates the concept of discursive institutionalism, which suggests that institutions are not just structures that constrain action but are also shaped by the ideas and discourses of individuals and groups. By integrating his framework, the study places a spotlight on both the structural and agential roles within institutions, acknowledging the transformative power of ideas and discourses in shaping institutional pathways towards sustainability.

1.6. RELEVANCE FOR INDUSTRIAL ECOLOGY

Industrial Ecology is a discipline that focuses on enhancing environmental practices within industries. The term "industrial" underscores its concentration on manufacturing processes. The field also draws inspiration from natural ecosystems, aiming to replicate their efficient resource cycling in industrial settings (Ayres & Ayres, 2002). Additionally, Industrial Ecology investigates how human technological activities interact with broader ecosystems, considering the sources of resources and the capacity to manage waste. This ecological perspective is connected to questions about the resilience of ecosystems and the potential impact of technological society on crucial environmental services (Gibbs & Deutz, 2007). This research is relevant for the field of Industrial Ecology as it examines the interactions between natural systems, human activities, and policy interventions. The study explores the empirical evidence surrounding how the water boards shape the transition towards the circular use of dredged material. The findings of this investigation may provide insights into how industrial processes can be redesigned and harmonized with ecological systems, fostering a more symbiotic relationship between economic development and environmental stewardship (Baldassarre et al., 2019).

1.7. RESEARCH STRUCTURE

This research unfolds across eight chapters, beginning with Chapter 2, "Theoretical Framework," where foundational theories and concepts are established to guide the analysis. Chapter 3, "Research Design," delineates the methodological blueprint for data collection and analysis. In Chapter 4, "Setting the Stage: The Circular Dredging Consortium and Its Water Board Participants," the operational backdrop of the CBC and its affiliated water boards is depicted. The empirical journey commences with Chapter 5, "The Rules of the Game," exploring the regulatory and normative frameworks governing water boards. Progressing to Chapter 6, "Textual and Discursive Regularities," the research scrutinizes communicative patterns within these entities, signifying their stance on circularity. Chapter 7, "Institutionalization," investigates the embedding of circular practices into the water boards' operational and cultural ethos. The narrative culminates in Chapter 8, "Conclusion," which synthesizes the findings, discusses theoretical and practical implications, and proposes recommendations, while also charting avenues for future research, thus providing a comprehensive view of the water boards' path toward sustainable dredging practices.

2. CONCEPTUAL FRAMEWORK

Prior to delving into the research, it is imperative to establish a foundational understanding of key concepts. These concepts, when elucidated, will serve as essential lenses through which the subsequent analysis will be conducted. The concepts include, circularity, sustainability transitions, agency and discursive institutionalism.

2.1. CIRCULARITY

The circular economy (CE) is a concept that proposes a regenerative and restorative economic model that aims to keep resources in use for as long as possible. The CE is gaining traction among policymakers and business leaders as a solution to the environmental, social, and economic challenges of the linear economy. The linear economy is characterized by the take-make-dispose model, where products are manufactured, used, and disposed of, leading to resource depletion, pollution, and waste generation (Grafström & Aasma, 2020). The concept of circular economy is defined by the European Commission in the EU Action Plan for the Circular Economy as follows:

> "In a circular economy the value of products and materials is maintained for as long as possible; waste and resource use are minimized, and resources are kept within the economy when a product has reached the end of its life, to be used again and again to create further value" (Directorate-General for Communication (European Commission), 2020).

The CE, introduced by environmental economists Pearce & Turner (1989), is a holistic approach that involves creating circular loops of energy, waste flows and material that include all actions in society. It holds the potential to bring substantial gains, such as reducing resource depletion, pollution, and waste generation, creating new business models and jobs, and enhancing resource security and resilience. The transition to a CE requires significant changes in the way resources are used, products are designed, and waste is managed.

The concept of circularity is central to this research, embodying a comprehensive approach to resource management. Specifically, it pertains to the repurposing of dredged material to reduce reliance on primary (construction) resources. Circular practices within the dredging industry entail the transformation of waste into reusable elements.

2.2. SUSTAINABILITY TRANSITIONS

Transitions are processes of change that occur gradually and continuously, leading to a transformation in the structure of a society or a complex subsystem within it. The changes can happen on different scales and over different time periods. The concept of transition is widely used in various scientific fields to describe a nonlinear shift from one dynamic equilibrium to another (Loorbach et al., 2017). More recently, the term 'sustainability transitions' has become more prominent. According to Loorbach and Rotmans (2010), sustainability transitions are radical and structural changes within societal (sub)systems. These transitions involve interconnected changes across various areas such as technology, institutions, the economy, culture, behavior, ecology, and belief systems (Rauschmayer et

al., 2015). The area of research has its roots in innovation research and environmental/sustainability sciences, which focused on addressing complex sustainability problems in the real world. As the field evolved, it broadened its focus to include societal systems more generally, including policies for transition management (Loorbach et al., 2017). A prominent perspective in sustainability transitions is the Multi-Level Perspective (MLP). The MLP is a well-known framework that analyzes transitions as interactions between developments at three levels: niches (the place for radical innovations), regimes (the dominant practices and rules), and landscapes (the broader external environment) (Geels, 2019).

The concept of sustainability transitions serves as a fundamental lens through which this research examines the transition towards circular use of dredged material by water boards. Within the context of the dredging sector, the notion of sustainability transitions signifies profound and structural changes occurring within the sector's multifaceted subsystems. These changes encompass a complex interplay of elements, ranging from technological advancements and institutional reforms to shifts in economic paradigms, cultural norms, behavioral patterns, ecological considerations, and underlying belief systems (Rauschmayer et al., 2015).

2.2.1. AGENCY

Sustainability transitions research has frequently faced criticism for its limited attention to the agency and diverse actors that play fundamental roles in shaping societal transitions towards sustainability (de Haan & Rotmans, 2018; Farla et al., 2012; Fischer & Newig, 2016; Pesch, 2015; Scholz & Binder, 2011; Wittmayer et al., 2017). The traditional focus on technological solutions and systemic structures has often neglected the intricate interplay of human choices, behaviors, and collective actions. For example, Farla et al. (2012) state that systemic transition perspectives 'might have come at the expense of a more actor-oriented and agency-sensitive analysis.'

Several scholars have attempted to account for agency in transitions research. For instance, De Haan and Rotmans (2018) introduce a framework in which 'actors', 'streams' and 'systems' encompass a 'transformative stage', which becomes central for explaining transformative change; Wittmayer et al. (2017) suggest that the operationalization of the concept of 'social roles' can be used as a transition governance intervention; and Pesch (2015) introduces the discursive fields framework, which focuses on the ways in which actors use language and social practices to create meaning and shape social reality, in this way understanding the mechanisms that drive change in sustainability transitions. Additionally, Geels (2011) argues that while agency is implicit in the MLP as actors enact the trajectories, it could be further enriched by integrating insights from other theories. This research proposes that Discursive Institutionalism offers valuable insights in understanding sustainability transitions in an institutional setting (Schmidt, 2015). It is introduced in the next section.

2.3. DISCURSIVE INSTITUTIONALISM

The term "discursive institutionalism," introduced by Vivien Schmidt (2008, 2010, 2015), asserts that understanding policy requires an understanding of ideas and discourse in an institutional political context, where ideas are the subject of discourse. It views institutions as structures where people speak, think, and behave as a result of their thoughts, words, and behaviors. Discursive institutionalism contends that a system should be internal to its constituents rather than external. In

this manner, the institution serves as both a structure that restrains actors and a construct that is created by and altered by the same agents. As a result, action within an institution can be seen as a process by which agents create and maintain an institution through their *background ideational abilities* (Schmidt, 2008, 2015). In terms of the ideational rules or rationality of that setting, this refers to the actors' capacity to comprehend and behave within a "given meaning context" (Schmidt, 2015). According to John Searle (1995), institutional rules exist and are unavoidably followed by actors. Because they are born into the rules or because these rules are a part of a larger hierarchy of institutional rules, people tend to forget about these rules after they have been established. In other words, an actor acts in the manner in which they do because they have grown accustomed to a structure that predisposes them to act in that manner; they do not need to be aware of the institution's rules in order to follow them. Actors build and maintain institutions using these background ideational abilities.

However, this does not explain how institutions change. Discourse becomes imperative here, given that change within an institution is a collective process. How ideas move from individual thought to change cannot be understood without looking at discourse (Schmidt, 2010). Schmidt's (2008, 2010, 2015) words, agents may also have *foreground discursive abilities*. These abilities enable actors within institutions to communicate, argue, and think about the institutional rules, and to persuade other actors to change or maintain these rules due to the actors' capacity to think, communicate, and act outside of the institution in which they act (Schmidt, 2008, 2010). Discursive institutionalism explains institutional change or continuity by combining background ideational and foreground discursive abilities.

2.4. DISCURSIVE INSTITUTIONALIST APPROACH TO SUSTAINABILITY TRANSITIONS

The analytical lens of Discursive Institutionalism makes it possible to delve deeper into the role of language, discourse, and institutional practices in shaping the trajectories of sustainability transitions. By focusing on discourse, this study aims to unravel the complexities of how different actors frame issues, articulate interests, and mobilize resources, thereby playing a pivotal role in shaping and governing transitions. Discursive institutionalism offers a nuanced understanding of how institutional contexts and norms intersect with human agency to co-create the evolving narratives of sustainability (Schmidt, 2010).

Anchored in the ideas of Richard Scott (2003, 2008b, 2008a), Audley Genus (2014, 2016) proposes a framework in which the focus on discourse in institutions and sustainability transitions integrate. The approach adopts a perspective that considers both language-related and structural aspects of conventions and rules governing sustainability transitions. Figure 1 presents a framework illustrating the proposed "discourse-institutional approach to understanding governance of sustainability transitions" (Genus, 2014). The Discursive Institutionalism approach to sustainability transitions offer a complex and multi-layered framework for understanding how language, institutional practices, and discourses influence sustainable practices within institutions. This approach emphasizes the interplay between various institutional layers, including formal and informal rules (Rules of the Game), language and narratives (Text-Discursive/Social Practice), and the mechanisms and processes through which

sustainability is embedded within institutions, known as institutionalization (Mechanisms/Carriers/Processes).

The 'rules of the game' is the layer that encompasses the fundamental norms and regulations that define the operational landscape. It includes not only formal policies and laws but also the underlying cultural and ethical norms that inform institutional behavior. This aspect is crucial as it sets the stage for what is considered acceptable or unacceptable in the pursuit of sustainability. In the layer consisting of the Text, Discursive- and Social Practice, the focus is on the power of language and communication. This involves examining how sustainability is discussed and framed within institutions, how narratives around sustainability are constructed, and the impact these narratives have on shaping institutional practices. It is about understanding the role of discourse in both reflecting and shaping the institution's approach to sustainability. Lastly, the institutional layer encompassing Mechanisms, Carriers, and Processes, is where the concept of institutionalization becomes crucial. Institutionalization refers to the process by which certain practices, rules, and discourses become embedded and normalized within an institution. The mechanisms, carriers, and processes are the conduits through which this institutionalization occurs. They can be tangible, like specific sustainability initiatives or policies, or intangible, like shifts in organizational culture or attitudes. This layer is about tracing how sustainability transitions from being an idea or a goal into an integral part of the institution's fabric (Genus, 2014, 2016).

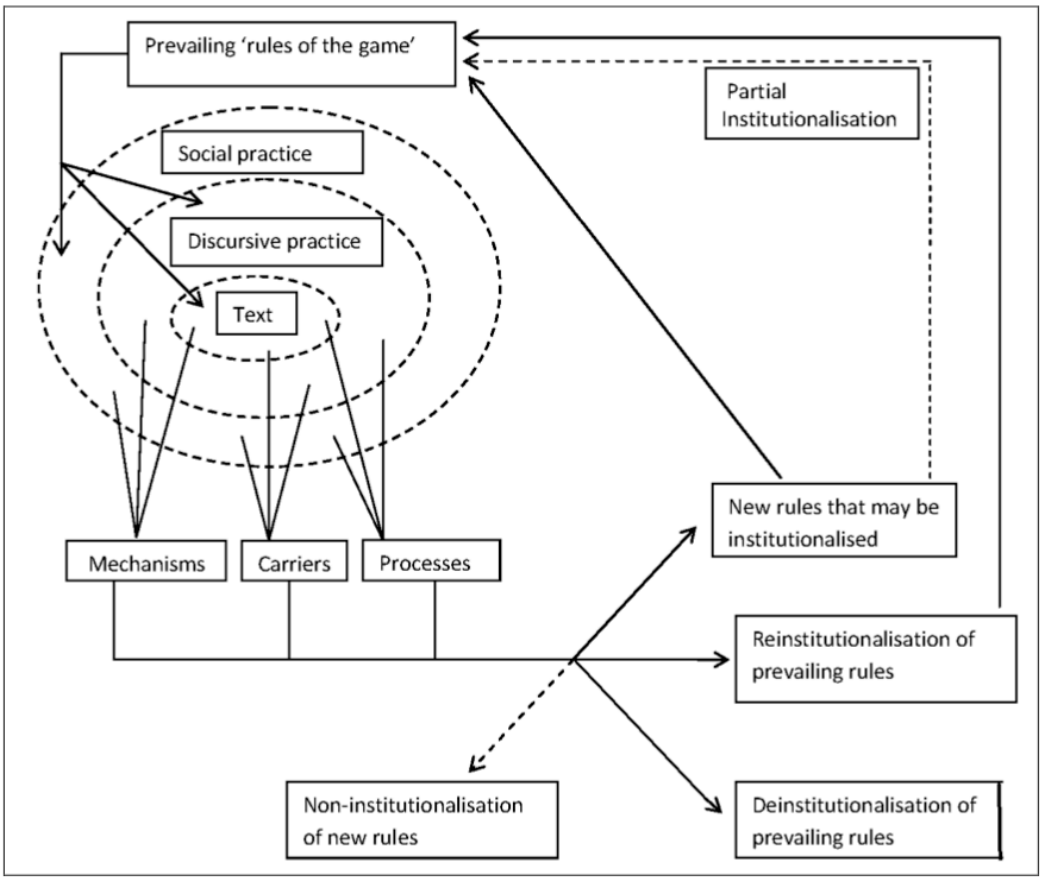

Figure 1. A discursive-institutional perspective of the governance of sustainability transitions. Taken from Genus (2014)

The added value of using this framework lies in its ability to reveal the complex and often hidden interconnections between language, social practices, and institutional structures. It helps in understanding how sustainable practices are either promoted or hindered within institutional settings (Genus, 2014, 2016).

2.4.1. OPERATIONALIZATION

In the case of Dutch water boards transitioning towards the circular use of dredged material, the discursive institutionalist approach to sustainability can be understood through a comprehensive lens that applies to this research. Initially, it delves into the regulatory and normative backdrop under which the water boards function, encompassing both the formal environmental laws and the informal practices that have historically guided the management of dredged materials. Simultaneously, the framework explores the language and narratives surrounding this transition, focusing on how concepts like circularity and sustainability are articulated and perceived within policy contexts and broader community discussions. This analysis is pivotal in understanding the shaping of perceptions and decisions. Furthermore, the framework extends to examining the actual implementation practices of circular use, investigating the adaptation of new methods, the challenges encountered, and if and how these emerging practices gradually become integrated and normalized within the operations of the water boards. This approach offers a multi-dimensional perspective, revealing the complex interplay between policy, cultural norms, and practical execution in driving the shift towards circular management of dredged material.

3. RESEARCH DESIGN

This research explores the role of Dutch water boards in the shift towards circular dredged material utilization and aims to address the empirical gap in understanding their influence. This chapter outlines the research design that underpins the investigation into the transition to repurpose dredged material within a circular economic model. It sheds light on the justification of the case selection, the research strategy and approach, its scope, methodologies, data collection and its limitations.

3.1. JUSTIFICATION OF CASE SELECTION

In examining the emergent and dynamic field of circular dredging practices, this research focuses on a particularly informative case study: the venture towards circular use of dredged material of three Dutch water boards – *Hoogheemraadschap Schieland en de Krimpenerwaard*, *Waterschap Hollandse Delta*, and *Hoogheemraadschap Rijnland*. These entities form the center of the Circular Dredging Consortium (Circulaire Bagger Consortium - CBC), which leads innovative strategies to repurpose dredged material.

The rationale for selecting these water boards as the focal point of this study is multifold. Firstly, their involvement with the CBC positions them at the frontline of circular dredging initiatives, not only within the national context of the Netherlands but on a potentially global scale, as such collaborative efforts in this domain are scarcely documented elsewhere. Their pioneering status offers a unique opportunity to explore uncharted territories in the shift towards a circular economy in dredging operations. Moreover, these water boards provide a lens through which it is possible to observe the nascent stages of this industry-wide shift. By concentrating on these specific cases, the research can delve into the complexities of institutional change, the challenges of pioneering new practices, and the strategies employed to navigate the intricate transition towards circularity.

3.2. STRATEGY & APPROACH

The research adopts a pragmatic philosophy that combines elements from different research paradigms to best address the specific problem (Giacobbi et al., 2005). This is to ensure a balanced approach that appreciates the empirical nature of policy documents and observable practices, while also valuing the subjective meanings and interpretations attached to them by water board professionals. The approach taken is a mixed-methods one, which enhances the solidity of the outcomes. This approach recognizes the complexity of the research subject and seeks to draw from the strengths of more methodological paradigms. It also facilitates triangulation, thereby enhancing the validity of the research findings (Mertens & Hesse-Biber, 2012). The strategy encompasses a case study approach, focusing on specific instances within the Dutch water boards to explore the transition to circular dredging practices. This strategy allows for an in-depth examination of the research questions within a real-life context.

The data analysis follows a thematic analysis framework, which involves identifying, analyzing, and reporting patterns (themes) within data. This will be coupled with narrative analysis to interpret the

stories and experiences conveyed through interviews and policy documents. Furthermore, the research employs purposive sampling to select cases, events, and participants that are most pertinent to the research questions and objectives (Berndt, 2020). This strategy ensures that the research focuses on instances that are rich in information and central to the transition towards circularity in dredging practicesp. Finally, to maintain rigor, the research follows the principles of credibility, transferability, dependability, and confirmability (Anney, 2014). It involves continuous comparison between the data, the emerging insights, and the theoretical framework to ensure that the findings are well-founded and can be trusted.

The following sections will detail the scope, methodologies, data collection practices, and limitations, all of which are designed to align with the overarching strategy and approach of this study.

3.3. SCOPE

This section delineates the scope of this research. This is necessary to understand the various boundaries that the research focuses on.

3.3.1. UNIT OF ANALYSIS

In this study, the unit of analysis is the transition process within water boards towards the circular use of dredged material. The focus is on how these water boards, as key actors within the dredging ecosystem, navigate and shape the shift towards sustainable practices in the management and repurposing of dredged sediment. The analysis goes beyond mere operational activities to encompass the complex interplay of regulatory, normative, and practical factors that inform the institutional change towards circularity. This includes examining the discourses, practices, and decision-making within water boards as they collaborate within frameworks like the Circular Dredging Consortium (CBC) and confront the challenges of adopting new, circular methods. The water boards' engagement in this transformational process, influenced by existing structures and their ability to innovate within the realm of environmental governance, provides a pivotal perspective on institutional adaptation to sustainability goals.

3.3.2. GEOGRAPHICAL SCOPE

The geographical scope of this research is situated within the Netherlands, with a purposive sampling of regions that are significant to the country's dredging operations and, more importantly, to the Circular Dredging Consortium (CBC): the water boards of *Hoogheemraadschap Schieland en de Krimpenerwaard*, *Waterschap Hollandse Delta*, and *Hoogheemraadschap Rijnland* (see Figure 2). These regions represent the forefront of innovation in circular dredging practices, making them the focal point for examining the intricacies of implementing circularity within the dredging sector.

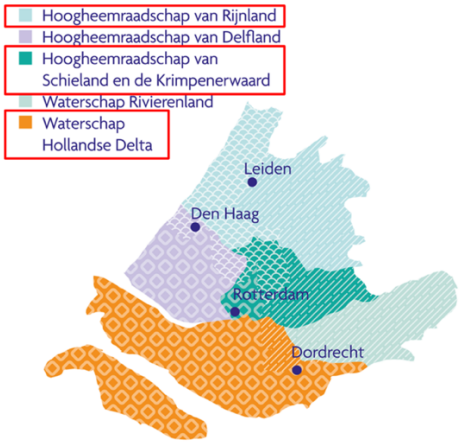

Figure 2. Map water board regions South Holland. Taken from CBC data base.

3.3.3. TEMPORAL SCOPE

This research spans a period from March 2017 to October 2023, allowing for a comprehensive understanding of the evolving dynamics of dredging and sediment management in the Netherlands. March 2017 marks the least recent publishing date of the policy documents I examine. I hence consider this the beginning of the ongoing transition towards circular use of dredged material. The gathering of empirical data spanned from May 2023 until October 2023. The temporal scope allows for the analysis of both historical (textual) and contemporary practices, creating a fuller picture of the transitional process.

3.4. METHODOLOGIES

This research addresses three sub-research questions to answer the main research question. Each research question requires different methodologies to be able to answer it. The required methodology for each sub-question is elucidated below.

For the first sub-question addresses about the current "rules of the game" governing the dredging ecosystem, as conceptualized by Genus (2014). These are the fundamental norms and regulations that define the operational landscape. It includes not only formal policies and laws but also the underlying cultural and ethical norms that inform institutional behavior. To gain an in-depth understanding of the dredging ecosystem, especially from the vantage point of water board operations, the study undertakes a comprehensive review of existing literature. Given the industry's complex nature and the scarcity of extensive documentation in academic literature, the research leverages the CBC database to supplement and enrich this understanding.

Building on these insights, the second sub-question addresses the regularities in texts and discursive practices evident as water boards transition towards the circular use of dredged material. Here, an exploratory qualitative approach is employed, focusing on the analysis of institutional documents, conducting interviews, and engaging in participant observation. This approach is designed to unpack

the narrative structures that inform and influence the perceptions and practices of professionals within water boards.

Finally, building on the previous chapter's exploration of textual and discursive regularities, the third sub-question advances the discussion by examining the degree to which these emergent narratives and practices around circularity are becoming institutionalized within water boards' operations. It explores the extent of institutionalization of regulative, normative, and cultural rules pertaining to circular dredging within water board operations. The study examines the manifestation and impact of coercive, obligatory, and mimetic mechanisms and their carriers, as posited by Genus (2014). The assessment relies on the textual and discursive patterns unearthed in response to the second sub-question, determining the depth at which circularity-related rules have become embedded within the operations of water boards.

3.5. DATA COLLECTION

Using various research techniques enables the triangulation of data, enhancing the solidity of the outcomes (Mertens & Hesse-Biber, 2012). The required data are explicated below.

3.5.1. CBC DATABASE

For the initial sub-question probing the fundamental norms and regulations that define the operational landscape of the dredging industry, the research used the CBC database as a primary data source. This repository offered a unique lens into the operational intricacies and regulatory environment of the dredging industry, which are not typically accessible through public channels. The CBC database provided a variety of non-public information, including internal policy documents, procedural guidelines, and communications among consortium members. Accessing this non-public database allowed for a deeper dive into the dredging industry's practices.

3.5.2. POLICY DOCUMENTS

The primary focus of this research is to analyze how water boards, particularly *Waterschap Hollandse Delta*, *Hoogheemraadschap Schieland en de Krimpenerwaard*, and *Hoogheemraadschap Rijnland*, navigate the transition towards circularity through the repurposing of dredged sediment as part of their sustainability strategies. The research aims to understand the institutional discourse within these organizations and how it shapes the transition. Part of the discursive analyses entails the study of relevant institutional documents. The selection of policy documents follows a purposive sampling strategy, focusing on those most pertinent to understanding the transition towards circularity. To ensure a systematic and comprehensive approach to document selection, the following strategy was devised:

1. *Explore official websites water boards authorities*:
    - Visit official websites of *Waterschap Hollandse Delta*, *Hoogheemraadschap Schieland en de Krimpenerwaard*, and *Hoogheemraadschap Rijnland*.

- Visit official website of *Unie van Waterschappen* – serves as a umbrella organization for the 21 water boards in the Netherlands (Unie van Waterschappen, 2023). Relevant because their publications serve as guidance for the water boards.

2. *Define search keywords*:
    - Relevant terms entail circularity, circular economy, sustainability, sustainable, dredged sediment, dredging, reuse, and repurposing.[2]

3. *Consult stakeholders:*
    - Collaborate with water board professionals for document recommendations.

4. *Consider publication dates:*
    - Taking into account the most recent publications of each water board and the union of water boards.

Based on the strategy the following documents in Table 1 were selected.

Table 1. Analyzed documents

Documents	Organization
D1 – "Agenda duurzaam wshd"	Waterschap Hollandse Delta
D2 – "Maat op klimaat: Op weg naar een veilige en schone toekomst"	Waterschap Hollandse Delta
D3 – "Nota Duurzaamheid"	Hoogheemraadschap Schieland en de Krimpenerwaard
D4 – "Rijnland Circulair"	Hoogheemraadschap Rijnland
D5 – "Waterschappen 100% circulair in 2050"	Unie van Waterschappen
D6 – "Het verhaal van de circulaire waterschappen"	Unie van Waterschappen
D7 – "Tijdlijn duurzaamheidsambities waterschappen"	Unie van Waterschappen
D8 – "Strategie duurzaam opdrachtgeverschap waterschappen 2021-2030"	Unie van Waterschappen

3.5.3. INTERVIEWS

Semi-structured interviews with water board employees were central to the data collection process. Table 2 provides a list of interviewees who were interviewed by the CBC, while Table 3 shows those interviewed by me. In addition to policy document and observation analyses, these interviews served as platforms to capture the explicit viewpoints of water board professionals involved in the dredging industry, particularly concerning the transition to circular use of dredged material. Engaging directly with water board employees allowed this research to delve into the underlying perspectives, motivations, and constraints shaping their perceptions of the water boards' role in fostering circular use of dredged material.

[2] Keywords translated to English from Dutch.

The interviews I conducted were semi-structured, allowing participants the freedom to express themselves beyond the confines of a fixed question-and-answer format. This approach, anchored in open-ended questions, encouraged the exploration of unforeseen topics and insights, fostering a more comfortable setting for interviewees (Barbour & Schostak, 2005). To ensure data reliability, an interview protocol was established in advance, as detailed in Appendix B. Appendix A presented the list of questions used in the CBC's interviews.

While the interviews conducted by the CBC were not tailored specifically to the needs of my research, they nonetheless provided valuable insights into the attitudes and perceptions of water board employees regarding the transition to circular use of dredged material. These interviews helped shed light on the practical challenges, cultural mindsets, and the strategic thinking that underpin the water boards' approach to circularity. The open discussions revealed through the CBC's interview process complemented my own semi-structured interviews, painting a more comprehensive picture of the complexities involved in adopting circular practices within the institutional framework of the water boards.

Table 2. List of interviewees – conducted by CBC

Interviewees
R1 – Interview with employee at *Waterschap Hollandse Delta*
R2, R3 – Interview with two employees at *Hoogheemraadschap Schieland en de Krimpenerwaard*
R4, R5, R6 – Interview with three employees at *Hoogheemraadschap Rijnland*
R7 – Interview with employee at *Unie van Waterschappen*
R8 – Interview with employee at *Waterschap Hollandse Delta*
R9 – Interview with employee at *Hoogheemraadschap Schieland en de Krimpenerwaard*

Table 3. List of interviewees – conducted by the author of this study

Interviewees
R10 – Interview with employee at *Waterschap Hollandse Delta*
R11, R12 – Interview with two employees at *Hoogheemraadschap Rijnland*
R13 – Interview with employee at *Hoogheemraadschap Rijnland*

3.5.4. PARTICIPANT OBSERVATION

Furthermore, participant observation complemented the interview data. Participant observation is a research method often used in social sciences, such as anthropology and sociology, where researchers immerse themselves in the natural settings of the subjects they are studying (Kawulich, 2005). This method involves actively participating in the daily activities, interactions, and experiences of the group being observed, while also taking on the role of an observer. During participant observation, researchers become a part of the community or group they are studying, allowing them to gain a deeper understanding of the group's culture, behaviors, and perspectives (Musante & DeWalt, 2010). This method proved valuable because it enabled the collection of rich and detailed data, often inaccessible through other research techniques. Being present and participating in the environment provided insights that extended beyond what interviews could reveal. It was possible to observe social interactions, rituals, and informal behaviors that contributed to a holistic view of the

group's lifestyle (Spradley, 2016). By immersing myself in the context of water board operations and interactions in the CBC and beyond, I derived valuable insights from observing practices, discussions, and interpersonal dynamics that contributed to the overarching discourse. Observation moments were carefully selected to provide rich qualitative data, contributing to the research's credibility and dependability. Table 4 presented the events and gatherings that I attended for participant observation purposes.

Table 4. Participant observation moments

Observation moments	Description
O1 – May 25th, 2023	Quarterly CBC session discussing stakeholder bottlenecks in circular dredging transition, with group discussions and data collection via cards.
O2 – August 9th, 2023	Online CBC meeting to create a unified vision for a circular dredging value chain in response to identified bottlenecks
O3 – August 29th, 2023	Preparatory online meeting for Baggernetdag, aligning CBC stakeholder expectations and objectives.
O4 – September 6th, 2023	Podcast recording for WOW-platform[3] with CBC co-founders and a water board representative to publicize their cooperation initiative.
O5 – September 21st, 2023	Quarterly CBC session focused on envisioning and revising procurement processes for enhanced circularity in dredging.
O6 – September 25th, 2023	Baggernetdag [4] event emphasizing circular use of dredged material, with presentations and networking to share knowledge and strengthen professional ties.

3.6. CODING STRATEGY

For the systematic analysis of the institutional documents, the interview transcripts and participant observation notes, this research relied on the coding process proposed by Juliet Corbin and Anselm Strauss (1990). This systematic coding process allows for the identification of themes and categories that emerge directly from the data, ensuring that the findings are rooted in the empirical reality of the studied context (Corbin & Strauss, 1990). The coding process' inherent flexibility aligns with the multifaceted nature of the research subject, allowing for the emergence of novel insights and a deeper understanding of the practices and mechanisms employed by water board actors in transition process towards sediment repurposing. The coding process employs three phases: open coding, axial coding, and selective coding (Corbin & Strauss, 1990). *Open coding* initiated the coding process by iteratively examining the dataset to identify and categorize events, actions, and processes. These were given conceptual labels that reflect their properties (Chandrasegaran et al., 2017; Corbin & Strauss, 1990). Following this, *axial coding* established causal and semantic connections between

[3] The WOW Platform serves as a meeting point for fostering interaction, knowledge exchange, and cooperation among government bodies responsible for road and water management at the national, regional, and local levels, as well as harbor and drinking water companies (Platform WOW, 2023).

[4] *Baggernet* aims to enhance the network of expertise and connections in waterbed management and dredging works. The core idea is that when professionals within the field know each other and can collaborate more effectively, there's increased sharing and utilization of knowledge and information, ultimately leading to more efficient waterbed management (*Wat Is Baggernet?*, 2023).

concepts, leading to the creation of descriptive labels. *Selective coding* followed, where central concepts that unify the descriptive labels were identified, answering the question of how to concisely represent findings (Corbin & Strauss, 1990).. Throughout these stages, taking notes was integral, either preceding data categorization or by capturing general observations about dataset components (Chandrasegaran et al., 2017; Chun Tie et al., 2019). For the coding process I relied on the Computer-Aided Qualitative Data Analysis Software (CAQ-DAS) *Atlas.ti* (Chandrasegaran et al., 2017).

3.7. HUMAN RESEARCH ETHICS

With regards to the interviews and participant observation, I have undergone the HREC (Human Research Ethics Committee) procedure at TU Delft, which is a necessary step for researchers engaging in studies that involve data collected from Human Research Subjects. As per TU Delft Regulations on Human Trials, this procedure is mandatory for all master's students. The HREC process involves conducting a thorough risk assessment as part of the research design, with the aim of identifying and effectively addressing potential risks.

Based on my personal experience, undergoing this process ensured that my research adhered to ethical standards and prioritized the well-being of all parties involved. To initiate the HREC application, researchers must provide essential documents, including a completed HREC Checklist, Informed Consent materials, and a Data Management Plan (see Appendix C). The HREC checklist serves as a vital tool for evaluating the potential risks faced by participants and outlining the measures taken to mitigate them.

Foremost among the risks was the possibility of over-sharing with TU Delft information that participants in the CBC interviews had not consented to, coupled with the chance that the CBC interviewees might remain unaware of the data's reuse by a third party. To mitigate these concerns, I committed to maintain all personal data exclusively at CBC, transferring only non-personal data to TU Delft. Furthermore, due to the absence of an official consent form from CBC, I sought direct consent from interviewees for the use, storage, and sharing of their data.

3.8. LIMITATIONS

This section explores the limitations inherent in this research study. They should be considered when interpreting the results and generalizing the findings.

3.8.1. SCOPE LIMITATIONS

This research focuses on how Dutch water boards shape and navigate the transition towards the circular use of dredged material. The unit of analysis is particularly the transition within water boards. While this provides an in-depth look at institutional changes and the adoption of new circular practices, the findings may not encompass the entire spectrum of influences within the broader dredging ecosystem, including other governmental entities and private sector stakeholders. Furthermore, the geographical scope, while purposively chosen to capture the forefront of circular dredging innovations within South Holland's specific water boards, may have implications for the

broader applicability of the research findings. The insights gained are deeply rooted in the context of the Netherlands, and specifically within the operational regions of *Hoogheemraadschap Schieland en de Krimpenerwaard*, *Waterschap Hollandse Delta*, and *Hoogheemraadschap Rijnland*. Consequently, the transferability of conclusions to different geopolitical environments, with varying governance structures and dredging practices, may be limited (Yin, 1998; Zucker, 2009). Finally, in terms of the temporal scope, the study encompasses a significant period from March 2017 to October 2023, which allows for a rich analysis of both historical and current practices. However, this demarcation means the research may not capture ongoing or future shifts in policy or practice that emerge subsequent to October 2023. As such, the study's findings may not fully reflect the most current or forthcoming developments in circular dredging initiatives (Yin, 1998).

3.8.2. METHODOLOGICAL LIMITATIONS

Data availability has presented challenges throughout the course of this research. A significant portion of the dredging industry's operations, particularly those related to repurposing dredged material, lacked extensive documentation in the existing (grey) literature. Despite efforts to bridge this knowledge gap through the use of the Circular Dredging Consortium (CBC) database and participant observation, this study may still have been constrained by the availability and completeness of relevant data. Moreover, the use of participant observation, while valuable for gaining insights into the daily practices and interactions of water board professionals, is subject to the limitations of researcher subjectivity and the potential observer effect. My presence during observations may have influenced the behavior of participants, and my interpretation of events may have introduced bias (Musante & DeWalt, 2010). Additionally, while I have made efforts to interview a diverse group of water board employees, the sample size is relatively small. Consequently, the findings may not fully capture the diversity of perspectives within water boards. Furthermore, the purposive sampling of interviewees conducted by the CBC and me may not represent all relevant stakeholders in the field (Berndt, 2020).

3.8.3. DATA ANALYSIS LIMITATIONS

The application of coding and analyzing data underpins the methodological rigor of this research. Nonetheless, it is important to acknowledge that the process of coding can introduce a degree of subjectivity, potentially influencing the interpretation of themes and categories. Efforts have been made to mitigate such subjectivity and uphold the validity and reliability of the results. This includes adopting a systematic approach to the coding process and engaging in reflexive practices to account for personal biases. Despite these measures, the potential for coder bias remains. This is an inherent limitation of qualitative analysis, where the interpretation of data can be affected by the coder's perspective (Corbin & Strauss, 1990). Furthermore, the concept of data saturation is pivotal in qualitative research, denoting the point at which additional data does not lead to new information or themes. While comprehensive efforts have been made to collect a rich dataset and reach this point of saturation, it must be considered that within the constraints of the research timeframe and available resources, some nuances may remain unexplored (Braun & Clarke, 2021). Lastly, the interpretative nature of qualitative research means that my own background, experiences, and preconceptions as the researcher could have had an influence on the analysis and outcomes (Corbin & Strauss, 1990).

4. SETTING THE STAGE: THE CIRCULAR DREDGING CONSORTIUM AND ITS WATER BOARD PARTICIPANTS

Before moving on to the analyses, it is essential to introduce the case study, which is unique in its nature and still in its nascent stages. The focus is on three pioneering water boards in The Netherlands – *Hoogheemraadschap Schieland en de Krimpenerwaard*, *Waterschap Hollandse Delta*, and *Hoogheemraadschap Rijnland*. These organizations are part of a novel and distinctive collaborative endeavor, the Circular Dredging Consortium (Circulaire Bagger Consortium (CBC)), aimed at repurposing dredged material. The singularity of these water boards lies in the fact that there are no other known examples undertaking similar initiatives, making them significant cases to investigate. This research delves into how water board actors navigate through, and shape, the transition towards circular use of dredged material. This section will delineate the origin of the CBC, its vision, and its operational strategies, thus providing the necessary backdrop for this study.

4.1. CIRCULAR DREDGING CONSORTIUM (CBC)

In the Netherlands, there exists an annual excess of approximately 40 million cubic meters of dredged material. At the same time, there are fewer and fewer permits for deposition, while water authorities have ambitious circular ambitions. This presents a unique opportunity for the surplus to serve as a valuable resource within the Dutch construction industry. Yet, exploiting this potential necessitates a profound transformation throughout the entire chain. That is why the *Circular Dredging Consortium* (CBC) was established, a proactive initiative that arose from the lessons learned from prior endeavors to repurpose dredged material (*Hét Circulaire Bagger Consortium*, n.d.).

Since 2018, *Waterweg*, the organization leading this initiative, has been actively exploring ways to address the surplus dredged material. Initially, they undertook small-scale pilot projects to test the feasibility of repurposing this material for construction. For instance, in Rotterdam, they have paved several streets using pavement made from repurposed dredged material. While these pilots yielded promising results, it became evident that creating a truly circular product was untenable within the confines of the existing linear dredging system. The limitation of this system became evident as *Waterweg* observed the challenges faced during their pilot projects. These challenges ranged from the logistics of dredged material supply to the complexities of processing different types of dredged material effectively. Additionally, developing a widely accepted circular procurement process for both dredging and construction materials proved to be difficult (*Hét Circulaire Bagger Consortium*, n.d.).

The understanding emerged that to realize a meaningful change and transition from a linear to a circular model, a more comprehensive approach, involving multiple stakeholders, was required. And so, the CBC was established. This consortium represents a multi-year commitment, a collaborative venture that brings together key stakeholders, starting with the water boards, the province of South Holland and municipality of Rotterdam. Their collective objective: to orchestrate the transformation necessary to establish a circular dredging chain (*Hét Circulaire Bagger Consortium*, n.d.). Together with its partners the CBC drafted the following vision:

> *In 2030, all dredged sediment, from freely applicable to non-applicable, will be used in a 50% circular manner. This means that the dredged material will be used in a high-quality, CO2-neutral, and as locally as possible manner. We achieve this by collaborating throughout the supply chain and, when necessary, pre-treating the dredged sediment.*

Waterweg and its co-initiating partners, *Blauwe Bagger* – a specialist in separating and repurposing dredged material for conventional construction – and *Noorderwind* – a facilitator of impact-driven innovation and co-creation processes – have chosen to terminate the pursuit of small-scale pilot projects in favor of shaping a broader, more systemic change. The lessons distilled from these pilot endeavors now inform the CBC's strategy. The CBC promotes the active development of a circular ecosystem for construction with dredged material. This ecosystem is poised to revolutionize the management of excess dredged material, minimize waste, mitigate carbon emissions, and foster the use of dredged material as a valuable resource in construction while embracing circular construction materials. The CBC's origin can thus be traced back to the recognition of the limitations of past approaches, motivating a collaborative effort to promote a more sustainable and circular path forward for the dredging and construction sectors in the Netherlands (*Hét Circulaire Bagger Consortium*, n.d.).

4.2. CBC MEMBERS

The consortium is organized as follows: A core team responsible for organizing this project, a group of partners who have signed letters of intent to actively contribute to the circular dredging chain, and a group of supporters who may attend the quarterly meeting of the CBC to give input. Table 5. demonstrates the core team and partner stakeholders that are involved in the CBC. The group of supporters is excluded given that this research focusses on the three partners in the CBC: the water boards.

Table 5. Core team and partner stakeholders 'Het Circulaire Bagger Consortium' (CBC); (water boards highlighted in bold).

Team
Core Team
Waterweg
Blauwe Bagger
Noorderwind
Partners
Provincie Zuid-Holland (Province of South Holland)
Gemeente Rotterdam (Municipality of Rotterdam)
Waterschap Hollandsche Delta
Hoogheemraadschap Schieland en Krimpenerwaard
Hoogheemraadschap Rijnland

4.3. CBC INTENTIONS FOR A CIRCULAR VALUE CHAIN

It is important to emphasize that at the time of this research, the CBC was in the early phases of establishing a fully circular dredging chain. This nascent stage of development meant that the consortium's gatherings with its partners were primarily focused on strategizing and discussing the implementation of future circular practices for the use of dredged material. These meetings served as crucial platforms for brainstorming, sharing innovative ideas, and collectively overcoming challenges associated with transitioning to circular methodologies in dredging operations.

A particular focus was put on the so-called enablers and service providers of the circular value chain. Whilst the primary chain parties and process steps are known for a circular chain (which does not exist yet), many more parties are needed that surround the primary chain partners. These are the parties that outline the conditions (enablers) and the parties that provide support work for the primary chain partners (service providers). The CBC emphasizes that these parties also need to adapt to enable the scaling up of a circular chain. For example, enablers are government bodies that need to adjust their procurement procedures or regulatory challenges that hinder the creation of the chain. The initial focus of the CBC, hence, lies on the enablers, given their 'enabling role' in the chain. Correspondingly, so does the focus of this research. Figure 3 shows the overview of the primary chain and the surrounding service providers and enablers.

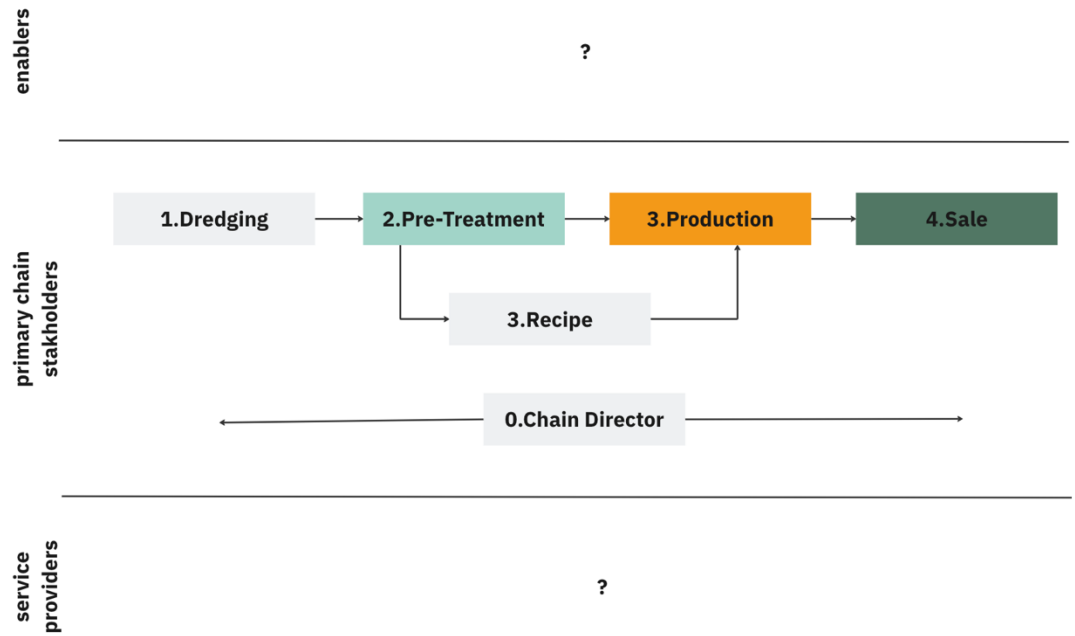

Figure 3. Overview circular value chain with surrounding enablers and service providers. Based on CBC database.

Given the initial focus of the ‘enablers’ in the future circular dredging chain, the CBC identified the most significant steps for enabling bodies to undertake. As per the CBC, enablers ought to:

- Establish prerequisites for a circular chain.
- Recognize the multifaceted role of the government as a client, facilitator, policymaker, enforcer, and promoter of a circular dredging and construction chain.
- Consider procurement processes for both dredging and construction materials.
- Address certification, standardization, and regulatory aspects related to dredging, including waste management, CO2 emissions, environmental impact, and life cycle assessment (LCA).

4.4. CBC APPROACH

The Circular Dredging Consortium (CBC) holds a meeting every three months, bringing together all stakeholders involved in the consortium. Each of these gatherings is dedicated to exploring a different aspect critical to the development of a future circular dredging chain. During my research, I had the opportunity to attend both the second and third quarterly sessions.

In the second session, the focus was on identifying and discussing the various challenges and potential hurdles each stakeholder faces or anticipates in transitioning towards the repurposing of dredged material. This session was interactive, with stakeholders engaging in group discussions to delve into specific issues. Smaller breakout groups allowed for more focused conversations on different challenges. Moreover, participants documented these challenges by filling out cards, which formed part of the research data. A key obstacle identified in the second session was the absence of a unified vision among stakeholders. To address this, the CBC organized an online meeting aimed at collaboratively developing a shared vision for a circular dredging value chain.

Building on this, the third session was particularly geared towards consolidating this shared vision. This turned out to be more contentious than anticipated, revealing differing perspectives and priorities among the participants. Furthermore, this session delved deeply into the procurement processes employed by water boards for dredging projects. A thorough understanding of these existing processes was deemed essential to identify potential modifications that could support a transition to circular practices. However, the varying interpretations of what constitutes 'circularity' among the partners added complexity to the discussions. This divergence in views directly impacted the conversation on revising procurement processes, as the very definition of circularity plays a pivotal role in determining the nature of the changes needed. Key questions addressed in this session revolved around the adaptation of procurement processes to enhance circularity. These included inquiries into the necessary roles, actions, and timelines for such a transformation, and more critically, the specific changes required in the procurement processes to align with circular principles.

In addition to organizing quarterly sessions, the CBC also places a strong emphasis on promoting awareness about the circular potential of dredged sediment. This effort took various forms during my research period. A notable initiative was the CBC's move to become a co-organizer of the *Baggernet*-day, a significant event in the field of waterbed management and dredging. Baggernet is dedicated to enhancing a network of expertise and connections within the waterbed management and dredging industry. The underlying principle of *Baggernet* is to foster closer relationships and collaboration

among professionals in the field, thereby facilitating the sharing and effective utilization of knowledge and information. This, in turn, aims to lead to more efficient and innovative practices in waterbed management (*Wat Is Baggernet?*, 2023).

The *Baggernet*-day is a key event where this collaboration comes to life. It gathered over 120 professionals, including dredgers, dredging specialists, and others in Rotterdam. The event featured a series of engaging presentations, hands-on excursions, and a networking reception, providing a rich platform for knowledge exchange and professional networking. With the CBC playing a co-hosting role, the event prominently featured the theme of circular innovations, specifically focusing on the use of dredged material as a valuable resource. The holistic approach taken by the CBC, despite the challenges and disagreements, highlight the consortium's dedication to tackling both the theoretical and practical elements critical to the successful establishment of a circular dredging chain.

5. "THE RULES OF THE GAME"

In the context of examining sustainability transitions from a discourse-institutionalist perspective, this chapter addresses the norms and regulations that define the operational landscape of the dredging ecosystem – i.e. "rules of the game." These rules encompass the fundamental norms and regulations that define the operational landscape. It includes not only formal policies and laws but also the underlying cultural and ethical norms that inform institutional behavior (Genus, 2014).

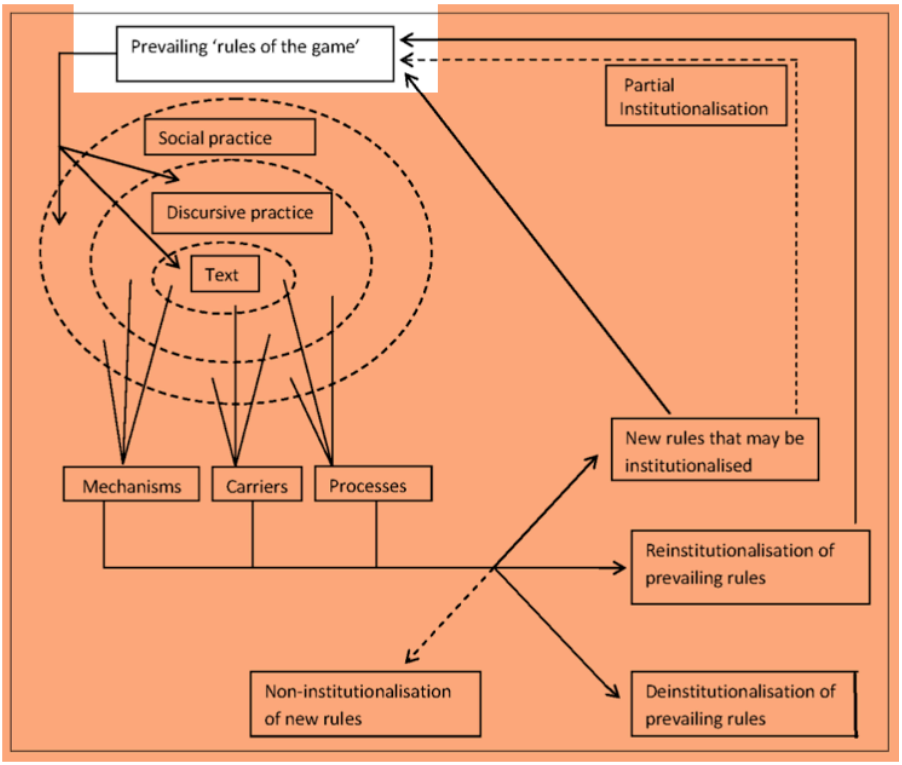

Figure 4. Discursive institutionalist approach to sustainability transitions – "rules of the game". Taken from Genus (2014)

This chapter emphasizes the stringent regulatory framework governing waterboard employees, highlighting their involvement with multiple stakeholders in the existing dredging chain. It also sheds light on the inherently conservative nature of the dredging industry. These aspects form a critical backdrop for understanding how water boards operate. In the next chapters, it will help to make sense of the language and narratives surrounding the transition towards circular use of dredged material, and to examine the institutionalization of circularity within the water boards.

5.1. DREDGING IN THE NETHERLANDS

Dredging operations within the Netherlands reflect a collaborative effort involving multiple stakeholders to ensure the navigability and ecological health of crucial waterways. Among these stakeholders, *Rijkswaterstaat,* the Dutch Directorate-General for Public Works and Water Management, is a significant actor. Rijkswaterstaat takes on the responsibility of overseeing and coordinating comprehensive dredging initiatives that encompass several strategically significant regions. The scope of these operations is considerable, encompassing various vital water bodies.

Rijkswaterstaat is primarily responsible for dredging activities in the extensive national waterways, encompassing networks of rivers and canals that serve as essential conduits for transportation and trade. Navigational routes within the North Sea, areas of the Wadden Sea, the harbor of IJmuiden, and the Westerschelde harbors all fall within the scope of Rijkswaterstaat's dredging efforts. The collaborative dimension of dredging operations extends further with Rijkswaterstaat's partnership with the *Havenbedrijf Rotterdam* (Port of Rotterdam Authority). Together, they shoulder the responsibility of dredging the Maasmond region and the network of rivers crisscrossing the Rotterdam harbor, one of the world's busiest ports. To execute these dredging initiatives effectively, Rijkswaterstaat establishes contractual arrangements with specialized dredging companies (Ministerie van Infrastructuur en Waterstaat, 2023b).

Whilst *Rijkswaterstaat* takes on a central role in maintaining specific national waterways, the responsibility for dredging in other areas is distributed among more local and regional governmental bodies. Provinces, municipalities, and regional water boards collectively shoulder the responsibility for dredging maintenance in waterways beyond Rijkswaterstaat's direct scope. This decentralized approach ensures a well-coordinated and comprehensive approach to preserving the integrity of the Netherlands' water infrastructure (Ministerie van Infrastructuur en Waterstaat, 2023b; “Waterbodembeleid en baggeren,” n.d.). The collaborative character of the national dredging system is also reflected int the more regional dredging practices. The regional dredging chain is an intricate, multi-layered operation characterized by the involvement of a multitude of stakeholders, which includes the commissioner (water board, municipality, or province), contractors, depots, subcontractors, samplers, and local farmers, among others. Figure 5 demonstrates how the current regional dredging chain for water boards is organized, and which stakeholders are involved in which step.

These parties collaborate at various stages, from sampling and analyzing dredged material to the tendering process, contractor selection, and execution of dredging work within specific environmental timeframes to ensure bird protection. The process also involves securing permits, transporting dredged material, and managing its disposal or application, with local farmers sometimes required to store dredge on their land if it meets chemical safety standards. Depots play a crucial role in managing both contaminated and non-contaminated material, overseeing its drying and subsequent transportation. This collaborative system is essential for maintaining the ecological health of waterways while meeting the logistical demands of the dredging process, ensuring compliance with regulations, and engaging with the community for the safe and efficient handling and application of dredged materials (For a more detailed explanation on each process step in the chain, see Appendix D. Appendix D also provides more information on the regulatory framework under which water boards operate).

In examining dredging within the Netherlands, and by considering Figure 5, it becomes clear that the country's approach is highly systematic and collaborative, involving many stakeholders like depots, samplers and various contractors. This section highlights a significant level of coordination required for dredging operations, reflecting a well-established ecosystem that is both efficient in maintaining navigability and ecological health. Yet, this means that the dredging ecosystem is potentially resistant to rapid change due to its complexity and the vested interests of various stakeholders.

Figure 5. Steps and actors in the current dredging chain.

5.2. CURRENT APPLICATION POSSIBILITIES

Dredged sediment can be applied in various ways. The regulation *Besluit Bodemkwaliteit* (soil quality decree) distinguishes between three application groups or quality classes:

- Application on land (*Dike reinforcement, Landfill capping, Road and site elevation*)
- Application on waterbed (*Bank blocks*)
- Spreading on adjacent plots (*Onshore, Meadow depot*)

The environmental characteristics of the dredged material have a significant impact on the potential (legally) to process it across various applications. Figure 6 demonstrates the different possibilities with dredged material per application group. As per the standards outlined in accordance with the *Besluit Bodemkwaliteit* the following points apply:

- Dredged material becomes an application on land if the dredged material is processed off-site, not on the same watercourse as the parcel. Filling in ditches, peat excavation pits (formed by peat excavation), or creating large-scale soil applications, such as dike reinforcements, sound barriers, and raising industrial areas, are also considered as land applications.

- With regards to waterbed applications, the principle of "no dirt on clean" applies. Clean materials categorized as Class *AW* have unrestricted applicability across various locations. Class *A* dredged materials can be applied in areas designated as Class *A* as well as those classified as Class *B*. On the other hand, Class *B* materials are specifically limited to use in areas categorized as Class *B*.

- With regards to spreading, dredged material may be processed on a parcel adjacent to or lying near the dredged watercourse, provided that its environmental quality meets the dispersion standard. Additionally, raising the level of a parcel after dismantling a meadow depot or processing dried dredged material in a regional embankment (along the respective watercourse) also falls under the category of 'spreading' of dredged material in the *Besluit Bodemkwaliteit*. In this case no assessment of the quality of the receiving soil is required.

Additionally, the following points are noteworthy to mention:

- If dredged materials are not suitable for land application and cannot be used on water – i.e. contaminated – they must be deposited in designated disposal depots. Disposal is explicitly not considered an application. In the Netherlands, there exists the option to safely store this contaminated dredged silt at several locations. For this purpose, a number of (temporary) dredged material depots have been constructed by the Dutch government. Currently, *Rijkswaterstaat* manages these depots. These are the *Slufter* on the Maasvlakte, *IJsseloog* in the Ketelmeer, the *Averijhavendepot* on the North Sea Canal, the *Hollandsch Diep* depot, and *Put Cromstrijen* (Ministerie van Infrastructuur en Waterstaat, 2023a).

- For applications on waterbeds and land applications, there's flexibility for local maximum values.

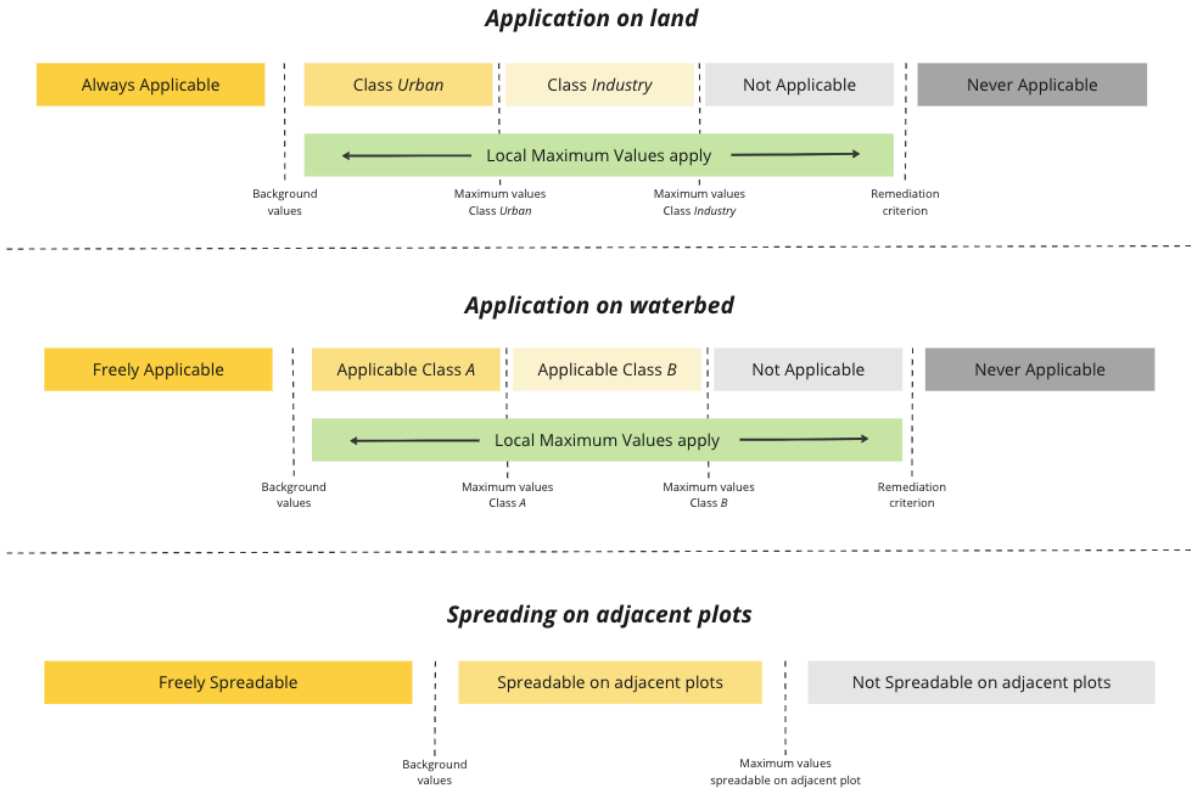

Figure 6. Application possibilities according to Besluit Bodemkwaliteit Based on source: Besseling et al. (2019)

Depending on the different applications of the dredged material, the dredging chains vary. For example, when spreading dredged material on the adjacent parcel, there won't be an intermediate transportation step, whereas applying soil for, for instance, dike reinforcement usually involves two transportation steps before and after drying at a transit depot. Figure 7 demonstrates the generic possibilities with regards to the different dredging chains.

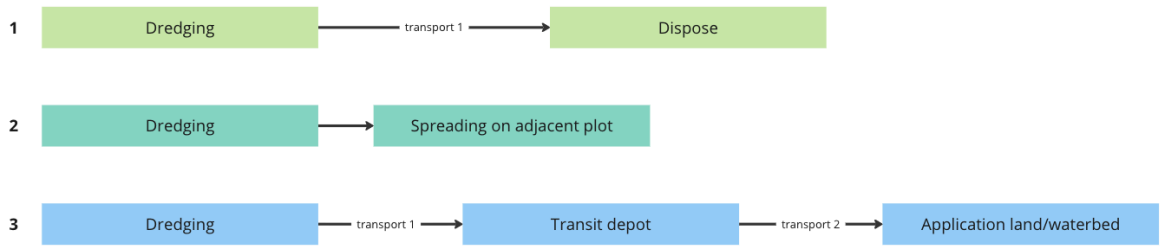

Figure 7. Different dredging chains depending on application dredged material. Based on Besseling et al. (2019)

The application possibilities for dredged material are governed by clear regulatory classes that dictate where and how these materials can be used, from land applications to spreading on adjacent plots. The analysis here points to a regulatory environment that is both prescriptive and provides a structure for various uses of dredged material. However, this regulatory framework also dictates the dredging chains and may limit the flexibility needed for innovative circular applications for the surplus dredged material that cannot be applied according to current practices (such as construction materials from dredged material).

5.3. WATER BOARDS IN THE DREDGING PROCESS

This section delves into the specific responsibilities that water boards undertake. Functioning as central coordinators within the dredging process, they shoulder substantial responsibilities that encompass various critical aspects of the operation. Through collaboration with diverse stakeholders, including contractors, depots, and local communities, water boards navigate a complex network of duties to ensure the effective execution of the dredging process.

5.3.1. MAIN RESPONSIBILITIES

Water Boards assume a comprehensive range of responsibilities throughout the dredging process, each contributing to the successful execution of the operation:

1. Sampling Coordination: Water Boards play a central role in overseeing the strategic sampling of materials targeted for dredging. Collaborating with depots, contractors, and samplers, they design meticulous strategies for accurate sample collection. These samples form the basis for well-informed decisions in subsequent phases.

2. Analytical Assessment: Water Boards exercise their authority to conduct comprehensive analyses of the collected samples. By employing cutting-edge laboratory facilities and skilled analysts, they delve into the composition, contaminants, and physical attributes of materials. This analysis leads to the classification of the material's "dredge class," influencing disposal methods and budget projections.

3. Collaboration with Depots: Water Boards collaborate with depots to assess and select suitable disposal sites. Leveraging environmental and regulatory knowledge, they ensure identified sites meet logistical needs while complying with regulations. This demonstrates their commitment to responsible management.

4. Project Specifications and Tenders: Utilizing expertise from various departments, Water Boards craft project specifications and issue tenders. Senior employees, in collaboration with supervisors, design detailed specifications that serve as the project's foundation. The procurement department ensures transparent and fair tendering processes, facilitating contractor responses aligned with requirements.

5. Contractor Evaluation: Water Boards extend responsibilities into evaluating contractor proposals with meticulous attention. A specialized committee comprising experts within the

Water Board assesses technical competence and environmental commitment. This ensures contractors align with project goals.

6. Regulatory Compliance: Water Boards play a key role in facilitating regulatory compliance. Collaborating with authorities, they secure essential permits required for the project. Simultaneously, their collaboration with contractors addresses permit-related prerequisites, ensuring alignment with regulations. More details about relevant regulations are explained in the next section.

7. Oversight and Collaboration: Throughout implementation, water boards maintain oversight, collaborating with contractors to ensure adherence to specifications and regulatory guidelines. This effort ensures efficient and controlled operations that align with project objectives.

8. Community Engagement: Water boards engage with local communities, particularly farmers, to allocate space for storing dredged material in line with environmental guidelines. This underscores their commitment to responsible community engagement.

Water boards are central to the dredging process, managing a broad spectrum of responsibilities from sampling to community engagement. Studying these responsibilities suggests that while water boards are well-positioned to influence the transition towards circularity, their traditional roles within the established 'rules of the game' may need to be redefined to fully embrace and implement circular practices.

5.4. CONSERVATIVE NATURE OF THE DREDGING INDUSTRY

Besides the formal policies and laws that characterize dredging in The Netherlands, the underlying cultural and ethical norms that inform institutional behavior, are important to identify as well (Genus, 2014). The Dutch dredging industry is often regarded as conservative, a characterization deeply rooted in its historical and cultural foundations, strong government relations, and reliance on established networks and family ties. Historically, the industry has been defined by a commitment to established practices and customs. This is not just a matter of operational strategies, but also a reflection of a broader cultural adherence to tradition. The industry's preference for traditional methods and approaches, ingrained over centuries, has played a significant role in shaping its conservative outlook. This historical backdrop, characterized by a rich legacy in water management and land reclamation, has fostered an environment where change is approached cautiously, with a high value placed on proven methods and reliability (Bouwens & Sluyterman, 2010).

Additionally, the Dutch dredging industry's relationship with the government has been a significant factor in its conservative nature. This relationship is characterized by mutual dependency and a close-knit connection, often reinforced through educational pathways. For instance, many industry leaders are graduates of Dutch technical universities. These educational ties have not only fostered strong connections with government engineers but have also cultivated a business environment where government-industry relations are paramount. This symbiotic relationship tends to favor established

practices and gradual evolution, as both parties often rely on a shared understanding and respect for historical methods and expertise (Bouwens & Sluyterman, 2011).

Furthermore, the industry's reliance on established networks and family ties has been a cornerstone of its business practices. This network-based approach, deeply rooted in local and regional connections, has historically encouraged a preference for familiar partnerships and practices. Family ties, in particular, have played a significant role in the continuity and stability of the industry, promoting a culture where longstanding relationships and trust are key elements of business operations. This emphasis on established networks and relationships has further reinforced the industry's conservative approach, favoring stability and continuity over rapid innovation or change (Bouwens & Sluyterman, 2010).

The conservative nature of the Dutch dredging industry, with its strong emphasis on tradition, established networks, and family ties, can act as both a stabilizing force and a barrier to change. The industry's cultural and ethical norms may slow the adoption of innovative circular practices, highlighting a potential tension between historical conservatism and the need for sustainability-driven innovation.

5.5. CONCLUSION

This chapter aimed to examine the fundamental norms and regulations that define the operational landscape of the dredging ecosystem in the context of Dutch water boards. The findings outlined in this chapter not only present a detailed view of the dredging ecosystem in the Netherlands, but also set the stage for the subsequent analyses of the transition towards circular use of dredged material within water boards. The conservative nature of the dredging industry, characterized by its reliance on traditional practices and methodologies, will likely form a significant aspect of this transition. This traditionalism, while ensuring stability and reliability, may also pose challenges to the adoption of innovative circular practices, which often require a departure from conventional methods. In the next chapters, this observation will help to understand the discursive practices and institutional dynamics that shape sustainability transitions in the context of dredging operations.

Furthermore, the structured and regulated framework within which the dredging activities operate, underscored by procedures outlined in documents such as the Besluit Bodemkwaliteit, provides both a foundation and a constraint for this transition. While these regulations ensure environmental and safety compliance, they can also act as barriers to the rapid implementation of new, circular approaches. The transition to circularity necessitates navigating these regulatory landscapes, balancing the need for innovation with compliance to established standards.

Additionally, the multifaceted role of water boards in the dredging process becomes even more crucial in the context of circularity. Their responsibilities, extending from material sampling to regulatory compliance, place them at the forefront of implementing circular practices. The transition to a circular approach will require water boards to not only rethink their operational strategies but also to engage in new forms of collaboration with other stakeholders like dredging companies, depots, contractors, and local communities. This new level of engagement and collaboration is essential for embedding

circular principles in the dredging process, but it also requires a reevaluation of existing relationships and power dynamics among these stakeholders.

The complex web of stakeholder interactions in the dredging ecosystem, highlighted earlier, becomes even more complicated in the context of this transition. Each stakeholder brings unique perspectives and interests, which must be harmoniously aligned to facilitate the shift towards circularity. The process involves not just technical and regulatory adjustments, but also significant shifts in mindset and institutional culture. Navigating these changes demands adaptive strategies, open communication, and a willingness to embrace new practices that may challenge the status quo.

In conclusion, this chapter lays a foundational understanding of the existing dredging ecosystem in the Netherlands, which is crucial for comprehending the nuanced challenges and opportunities in transitioning towards the circular use of dredged material. The conservative nature of the industry, the structured regulatory framework, the extensive responsibilities of water boards, and the complex stakeholder dynamics all play pivotal roles in shaping this transition. As this research delves into the discursive practices and institutional dynamics in subsequent analyses, these foundational elements will serve as key lenses through which the feasibility and impact of sustainability transitions in the context of dredging operations can be assessed and understood.

6. TEXTUAL AND DISCURSIVE REGULARITIES

As proposed by Genus (2014), "[t]he governance of environmental sustainability is depicted as regularities in text and discursive practice." Accordingly, this chapter focuses on patterns that are evident in the discourse within water boards as they shift towards the circular use of dredged materials. Figure 8 demonstrates the focus of this chapter in the framework of discursive institutionalist approach to sustainability transitions.

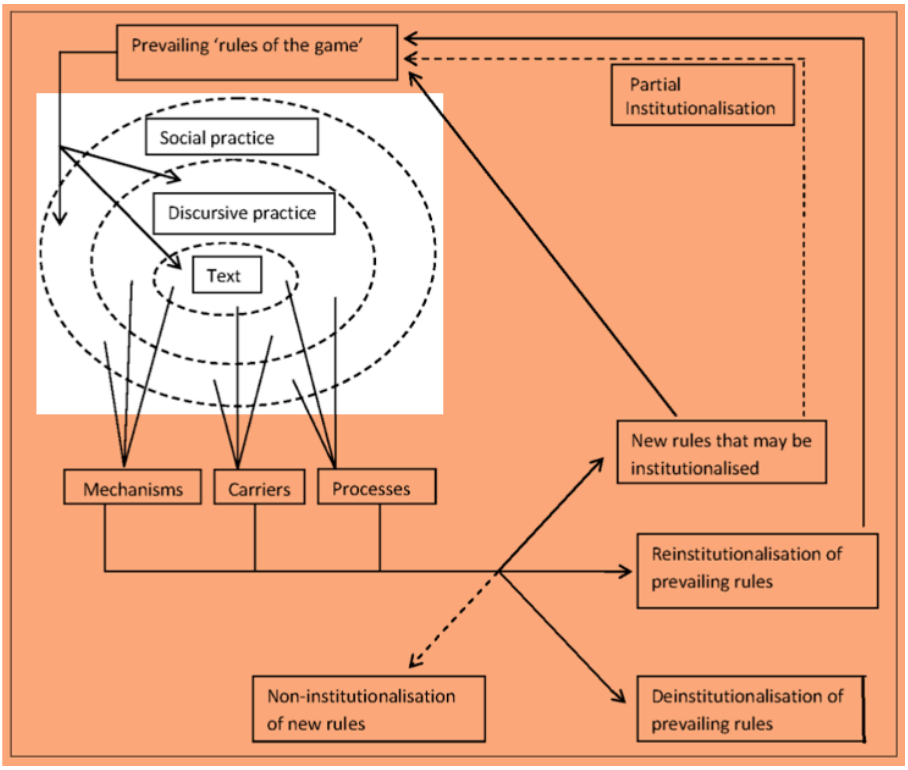

Figure 8. Discursive institutionalist approach to sustainability transitions – Social Practice, Discursive Practice, Text. Taken from Genus (2014)

In examining texts and discursive practices of water board employees in the transition towards circular use of dredged material, this chapter builds upon the foundational insights previously established regarding the conservative nature of the Dutch dredging industry and its intricate web of stakeholder interactions. A central finding of this exploration is the discernible dichotomy between the well-established 'rules of the game' and the nascent principles of circularity. This contrast is depicted in the texts and discourses stemming from water boards, encapsulating the coexistence of both enabling and inhibiting factors. On one side, there is a clear recognition of the necessity and benefits of embracing circularity, coupled with a growing intrinsic motivation among employees towards sustainable practices. Conversely, these progressive discourses are often offset by challenges such as organizational fragmentation, the absence of a universally accepted definition of circularity, and constraints in resources. These opposing forces highlight the complexities inherent in transitioning towards circular practices in a system not originally designed to support them.

The narrative surrounding this transition is further characterized by a series of tensions. Prominent among these is the juxtaposition of the comfort and familiarity associated with pilot projects against the uncertainties linked with systemic implementation. This scenario underscores a broader discursive struggle to balance the pursuit of immediate, tangible environmental goals, like CO2 reduction, against the pursuit of long-term, systemic advantages offered by circularity. Additionally, a notable gap is observed between the individual sustainability beliefs held by employees and the collective actions undertaken by their organizations. This gap underlines a discursive conflict within the water boards, reflecting the broader challenge of aligning personal values and convictions with the entrenched practices of the organization.

The insights gathered in this chapter provide a comprehensive overview of the dynamic and complicated process of transitioning towards the circular use of dredged material within water boards. The findings emphasize the significant role played by historical, cultural, and institutional factors in shaping this transition. This chapter paints a picture of a path to circularity that is widely acknowledged yet complicated by the legacy of established practices and norms. This complex interplay of factors offers a nuanced perspective on the challenges and opportunities inherent in the water boards' journey towards a more circular future.

6.1. DOMINANT NARRATIVE

The empirical data reveals a dominant narrative within water boards emphasizing the shift toward circular use of dredged material. This narrative is composed of various elements that either facilitate or challenge the transition. Key among these are enabling factors that drive the transition forward and inhibiting factors that pose obstacles to progress. The data, summarized in Tables 6 and 7, provides a comprehensive overview of these factors, laying the basis for understanding the complexities of this transition process

Table 6. Dominant narrative: enabling factors

Enabling factors
The goals are set and acknowledged
The will is there
Employees are learning

Table 7. Dominant narrative: inhibiting factors

Inhibiting factors
No uniform definition of circularity
Ownership: fragmentation within water boards and the dredging sector
Capacity constraints
Financial constraints

6.1.1. ENABLING FACTORS

The goals are set and acknowledged

Firstly, the data clearly reveals a collective consensus regarding the applicability of circularity goals to dredged material management. The circularity goals resonate in the policy documents and throughout the organization, and employees generally agree with the significance of these objectives. During gatherings that I attended, the need to become more circular in dredging practices was always the key subject, whether this was due to intrinsic motivation or merely because policy documents dictated the goals. Similarly, during interviews respondent were well aware of the circularity goals and need to take action to reach the goals. Table 8 shows an example quotation.

The set and acknowledged goals for circularity within water boards reflect a significant deviation from 'the rules of the game'. As highlighted in the previous chapter, the dredging industry has traditionally been guided by practices that prioritize stability and predictability. These practices are deeply ingrained and are often seen as 'safe' due to their proven track record in ensuring operational efficiency and regulatory compliance. However, the emergence of circularity goals represents a shift in this narrative, introducing a tension between maintaining these established traditional approaches and venturing into the relatively unexplored domain of circular practices.

Table 8. Example quotation "the goals are sets"

#	Example Quotation
1	*"So, those objectives from the Union of Water Boards, yes. We should take action on those." – R3*

The will is there

Moreover, the discourse reveals that the motivations of water board employees to become more circular are present. Yet, they exhibit a multifaceted nature, often influenced by their specific roles within the organization. Whilst some employees are motivated by the pressing need to address the issue of excess dredged material, which they perceive as a burden on their operations, others are driven by an intrinsic motivation to steer the organization toward greater circularity, perceiving it as a progressive step in environmental sustainability. For instance, see the quotation 1 in table 9.

A central focal point within this discourse is non-spreadable (contaminated) dredged material, perceived as the most challenging aspect of the transition. Employees place emphasis on finding practical applications for this type of dredged material. Quotations 2, 3, 4 and 5 in table 9 exemplify this tension. Here, it becomes clear that the contaminated dredged material is perceived as a problem in current dredging operations, motivating employees to find alternative disposal/ application possibilities for the dredged sediment, This, hence, steers them to feel motivated about the transition towards circular dredged material.

Additionally, regional disparities within water boards play a pivotal role in shaping motivation. Boards with predominantly urban areas encounter challenges in finding adjacent plots for spreadable (clean) dredged material, whereas those serving grassland regions find it relatively easier to deposit the sediment on meadows. This therefore meant that employees at the latter type of water board often

expressed more sustainability-driven motivations, whereas employees at the former type of water board were more concerned with finding a place to dispose of the dredged material and thus deemed circular use of it as a way to do so. Quotations 6, 7, and 8 exemplify this.

The will to innovate within water boards suggests a discursive shift from merely adhering to regulatory compliance towards seeking environmental sustainability. This shift is significant given the previous chapter's findings that highlighted the stringent nature of regulations that can sometimes hinder rapid innovation. Historically, the dredging industry, and by extension water boards, has operated within a tightly regulated framework. Such a regulatory landscape can on one hand, provide clear standards and stability, but on the other hand, it can stifle creativity and impede the adoption of novel, sustainable solutions.

The emerging will to innovate within water boards, therefore, represents a pivotal change. It signifies an acknowledgment that adhering to regulations, while crucial, is not sufficient in itself to address the broader environmental challenges facing the industry. This change in discourse reflects a growing recognition of the need to go beyond compliance and to actively seek out and implement sustainable practices that can have a more profound and lasting impact on the environment.

Table 9. Example quotations "the will is there"

#	Example Quotation
1	*"I myself, and I'm sure others as well, would highly value the full-time use of dredged material for various types and scales of projects." – R5*
2	*"So, basically, yes, you have that polluted dredged material. You need to dispose of it, and that just costs money." – R1*
3	*"Non-dispersible dredged material gets a useful destination instead of going to a landfill." – R2*
4	*"We need to focus more on the non-dispersible [dredged material]" – R4*
5	*"The relevance, you could say, lies in dealing with the contaminated dredged material, the part that is not applicable." – R8*
6	*"Due to urbanization, there's less and less room to put dredged material on the shore." – R1*
7	*"[…] such as dikes along the shore, new houses with piers, and, for example, solar parks where dredged material can no longer be placed on the shore." – R3*
8	*"We're indifferent to what happens beyond this point [with the dredged material], as long as we can dispose of it." – R10*

Employees are learning

The empirical data also highlights the presence of enthusiasm about the transition towards circularity in employee perspectives, especially with regards to the participation in the CBC. Between the first participant observation moment and the last that I attended, employees exhibit a clear shift from initial reluctance toward the implementation of circular ideas to growing enthusiasm toward the end of my research period. Many water board employees express satisfaction in participating in a circular dredging consortium, appreciating the opportunity to learn from and be inspired by entrepreneurs who initiate change, and by colleagues from other water boards. This indicates a genuine willingness to embrace circular practices. This mentality is also reflected interviews. See table 10 for an example quotation.

The learning initiatives indicate a transformative discourse, moving from the conservative industry perspective towards a more open and adaptive approach. The employees' growing enthusiasm for circular practices indicates a potential shift in the institutional culture, which is crucial for moving beyond the 'rules of the game' that have traditionally governed the industry. It allows for a reevaluation of the 'rules of the game' and opens the door for more innovative and sustainable practices to be considered and implemented. The growing enthusiasm among employees for circular practices can be seen as a catalyst for institutional change. As employees become more knowledgeable and supportive of circular principles, they are more likely to advocate for and implement changes in their work, gradually shifting the organizational culture towards one that values and prioritizes sustainability and circularity.

Table 10. Example quotation "employees are learning"

#	Example Quotation
1	*"I find it [participating in the CBC] quite interesting, and you do learn. You are somewhat compelled to look at things in a certain way that are actually taken for granted or that you wouldn't normally do." – R10*

6.1.2. INHIBITING FACTORS

No uniform definition of circularity

On the flip side, in the midst of the frequent mentions of circularity goals in the policy documents I examined, a notable inhibiting mechanism emerges due to the absence of a universally accepted definition of circularity, specifically when it concerns the management of dredged material. Policy documents often attempt to define circularity, but these definitions tend to be broad and general. For example, a typical definition might read: "The goal of circular action is to limit the impact of human activities to the rate at which the Earth can provide, in terms of both resources and materials as well as energy and natural values" (Waterschap Hollandse Delta, 2019). However, the broad definitions of circularity often fall short in addressing specific practices such as dredging. Consequently, circularity definitions were often formulated based on personal interpretations rather than adhering to a universally agreed-upon definition. For example, most employees struggled to answer what circular use of dredged material means (see example quotations 1 and 2 in table 11). Additionally, during the third CBC quarterly meeting, which was particularly geared towards consolidating the shared vision, this turned out to be more contentious than anticipated, revealing differing perspectives and priorities among the participants.

Accordingly, the water board organizations struggle to formulate a comprehensive and coherent plan for achieving circularity. Employees often highlight the difficulties arising from this absence of a shared vision and strategy within the organization. The lack of a universally agreed-upon understanding of circularity makes it challenging for employees to align their efforts cohesively towards attaining the established circularity objectives. Hence, no concrete plan is available that guides water board employees towards circular use of dredged material. Quotations 3, 4 and 5 in table 11 illustrate this.

Given the lack of a clear definition, the measurement of circularity becomes ambiguous. In other words, if you do not know what exactly circular dredging entails, it becomes difficult to measure how circular dredging practices are. Although the STOWA developed the CircSed tool to measure circularity, this has not yet been widely accepted and integrated in dredging practices. Consequently, the organization faces complexities and delays in its development towards adopting a more circular approach to its operations.

The absence of a uniform definition of circularity aligns with the previous chapter's findings of a highly structured and regulated framework governing the dredging ecosystem. The industry's conservative nature and the stringent regulatory environment create a comfort zone of established practices, which employees are hesitant to leave. Consequently, the challenge of defining circularity is not just a matter of lexical ambiguity, but rather a symptom of the industry's overarching tendency to cling to the familiar 'rules of the game.' This tendency hinders the conceptualization of circularity in a way that diverges from these established practices.

Table 11. Example quotations "no uniform definition of circularity"

#	Example Quotation
1	*"I am searching, but I have not found a good definition. It's still a quest. […] We are still searching for these definitions ourselves." – R1*
2	*"Circular is just reuse, isn't it? That's what it stands for, right? That it doesn't become waste, but that it's reused?" – R3*
3	*"No, we don't have a step-by-step plan. It could be better." – R2*
4	*"There are various roadmaps and, well, that sort of thing. There's a lot of it, but usually, it remains somewhat vague, more in the realm of high-level terms. It's not so much about what exactly we should do, what do we mean by it, and how many cubic meters of dredged material should we use effectively, for example." – R10*
5	*"In the ideal scenario, there is some sort of standard step-by-step plan, so to speak." – R13*

Ownership: fragmentation within water boards and the dredging sector

Furthermore, the discourse underscores the fragmentation within water boards and within the dredging sector as a significant obstacle to the transition toward circular use of dredged material. In the realm of business as usual, it's often not necessary to maintain close contact with other departments within a water board. However, when it comes to the transition towards circular use of dredged material, the need for interdepartmental collaboration becomes paramount. The collaborative effort required for this transition necessitates effective communication and cooperation across multiple departments within water boards, such as dredging teams, procurement, sustainability divisions and policy making departments. However, the collaborative endeavor often encounters several impediments. Employees frequently resort to placing responsibility on other departments. See quotation 1 in table 12 for example.

Similarly, employees often name contractors in the dredging sector to be responsible for the dredged material once it is taken out of the waterways – in this way being ambiguous about the ownership of the dredged sediment. Quotations 2 and 3 in table 12 exemplify this. Motivating colleagues to embrace circularity proves to be a common challenge as well for more ambitious water board

employees – further contributing to fragmentation. Quotations 4, 5 and 6 in table 13 demonstrate how water boards employees struggle to get their colleagues on board in changing current operations.

The fragmentation within water boards echoes the conservative nature of the industry identified in the previous chapter. Employees and departments may be wary of stepping beyond their traditional boundaries for fear of disrupting the established 'rules of the game,' which provide a clear, albeit rigid, pathway for operations and decision-making. The reluctance to deviate from conventional roles and responsibilities aggravates the challenge of establishing ownership of the circular transition, making it difficult to foster the collective action required for significant change.

Additionally, the fragmentation and reluctance to innovate in roles and responsibilities can lead to a diffusion of accountability. Without clear ownership, initiatives for circularity can become stalled, as no single entity or group within the organization may feel empowered or responsible to drive the change. This can result in a lack of initiative or a pass-the-buck mentality, where each department waits for others to take the lead, thus perpetuating the status quo.

Table 12. Example quotations "ownership"

#	Example Quotation
1	*"How do we approach circularity within the water board? The sustainability team is working on this. This team is leading the way." – R1*
2	*"The water board is not directive; the contractors determine what is circular and how it [dredged material] is disposed of." – R6*
3	*"And yes, you're basically just looking for something like, where can I dispose of my sediment so that someone else can do something with it?" – R9*
4	*"They are a really conservative team, you could say. Yes, they are like, 'Well, if it's not in the policy, we won't do it.'" – R8*
5	*"[…] Well, not many people were enthusiastic about starting this project because it involved quite a bit of work. Yes, it's a substantial task to set everything up, and you essentially have to detach it from your regular workflow, making it a separate project […] Yes, it's not an easy project to initiate." – R8*
6	*"So, I've already spoken to several managers, and they say, 'Yes, this is actually fantastic. We can do some really good things with this.' But the ones who are more operationally involved, I can't get them on board right now, so you can't really transfer that." – R13*

Capacity constraints

Moreover, the empirical data reveals that water boards face capacity constraints that pose challenges to the adoption of circular practices. Beyond the realm of circularity, these organizations are confronted with a multitude of other responsibilities and changes that ought to be initiated, such as renovation projects, digitalization, CO2 reduction, hence, competing for attention and resources. This abundance of competing priorities raises questions about resource allocation and time management. Employees find it challenging to find a balance between their regular tasks, and contemplating future changes such as circularity. The quotations in table 13 demonstrate this struggle.

The capacity constraints refer to both the physical resources and the human capital necessary to implement circular initiatives. The dredging industry, being traditionally conservative, may not have the requisite expertise or may not prioritize the development of skills needed for the adoption of circular practices. This is because the prevailing operational models and investments have been fine-tuned to optimize the existing linear processes, which are well-established and understood within the industry. These constraints, as highlighted in the empirical data, are a continuation of the challenges outlined in the previous chapter where the focus was on how the 'rules of the game' within the dredging ecosystem are governed by a conservative and risk-averse mindset.

Table 13. Example quotations "capacity constraints"

#	Example Quotation
1	*"And, you also see, we are getting more and more tasks. For example, all the pumping stations were, of course, built in the 1970s. Well, they are all 50 years old now, so they are starting to creak and groan a bit. So, naturally, we now have to replace, adapt, or renovate all of them." – R4*
2	*"Yes, yes, because you want to make a change, but meanwhile, the regular work continues as well." – R10*

Financial constraints

A substantial obstacle that becomes evident from the face in their transition is the lack of extra funds allocated for the various changes required for the transition to circular dredging practices. This financial constraint presents a significant barrier to initiating necessary transitions. In the gatherings I attended for participant observation, it was frequently emphasized that the process would be less complicated if funding were limitless. During observation moments and interviews employees confirmed this bottleneck many times (see table 14 for some example quotations).

Similarly, to the capacity constraints, financial constraints are a product of the traditional focus on compliance and environmental safety, which commands a significant portion of water boards' budgets. These financial structures often do not account for the investment needed to innovate or experiment with circular practices, which are still considered to be unproven or higher risk compared to traditional methods. Moreover, the financial models and accounting practices that govern the allocation of funds within water boards may not be favorable to the upfront investment required for circular initiatives, which may have longer-term payoffs and less immediate returns on investment. This is complemented by the fact that the cost savings or environmental benefits of circular approaches are often not fully quantified or appreciated within the traditional financial frameworks, making it challenging to justify the allocation of funds towards such initiatives.

It is also significant to note that financial and capacity constraints are interconnected. The capacity to innovate is often limited by financial resources, and conversely, the availability of funding can be constrained by organizational capacity — if there is not enough skilled personnel to design and implement circular practices, financial resources may remain unutilized or be allocated to less risky, traditional projects. In a sector where every expenditure must be justifiable in terms of compliance and risk management, convincing the decision-makers to invest in innovative but uncertain circular initiatives can be a significant hurdle.

Table 14. Example quotations "financial constraints"

#	Example Quotation
1	*"The water board is a financially driven organization. It [transition] must not incur too many additional costs." – R5*
2	*"That is one of the barriers: Money!" – R7*
3	*"Now, we are also becoming more diverse, reasonably funded by the government, but that fund is bound to run out eventually. Or, well, we have more tasks than money." – R8*

6.2. TENSIONS IN THE NARRATIVE

Within the discourse, tensions arise that reflect the complexities and challenges inherent in the transition toward circularity in dredged material management. Table 15 demonstrates the tensions that are present in the dominant narrative, which I explain in this section.

Table 15. Tensions in the narrative

Tensions in the narrative
Pilot projects are the way to go VS. Move beyond pilot projects
Wait for market before embracing circularity VS. Water boards should steer the market
Focus on CO2 reductions VS. Embrace circular use of dredged material
Contradictions in personal perceptions

Pilot projects are the way to go VS. Move beyond pilot projects

The initial tension that emerges is the contrast between advocating for pilot projects as a means of experimentation and acknowledging the imperative for systemic, long-term change. Employees exhibit reservations when it comes to transitioning from pilot phases to full-scale, comprehensive implementation. While some employees emphasize the importance of adopting a balanced approach that encompasses experimentation while also delineating a clear roadmap for the adoption of circular practices, there are others who struggle to envision a trajectory beyond the initial pilot phases. This tension highlights the challenge of bridging the gap between innovation and integration. On one side, there is a recognition of the value of piloting to test and refine new approaches. However, on the other side, there's a reluctance to fully commit to the sweeping changes required for a complete transition to circular practices. Table 16 shows two example quotations that exemplifies this tension.

In the context of the water boards transitioning towards circular use of dredged material, the reliance on pilot projects can be seen as a small but relevant exemplification of the industry's broader conservative disposition. The pilot projects serve as controlled environments where new ideas can be tested with limited risk to the overall system. This approach is comfortable for an industry that is traditionally risk-averse, allowing for innovation within clearly defined boundaries. It aligns with the 'rules of the game'—the established norms and procedures that provide stability and predictability to the dredging ecosystem.

However, the contrast between these safe, small-scale pilot initiatives and the large-scale systemic changes required for a true transition to circularity reveals a deeper discursive struggle. On one hand, there's recognition of the need for institutional innovation to address environmental challenges and to improve sustainability practices. On the other hand, there's an inherent institutional inertia that resists such changes because they represent a departure from the tried and tested methods that have historically defined the industry.

This tension is not merely operational but is essentially discursive, as it reflects the narratives, beliefs, and values that are prevalent within the industry. The discourse surrounding pilot projects is often one of cautious optimism, where success stories are celebrated, but the scalability of such projects is met with skepticism. The narrative is one that values learning and experimentation but within a framework that does not disrupt the existing order too drastically.

Table 16. Example quotations tension "pilot vs beyond pilot"

#	Example Quotation	
	Pilot projects are the way to go	Move beyond pilot projects
1	*"Yes, simply knowledge sharing, and indeed, I see pilots as just that. It's the best way to do something, to carry out a project for a bit longer." – R8*	*"There are many colleagues who are willing to undertake various initiatives. They may carry out a small pilot, sometimes a somewhat larger one, but often it remains somewhat within their own team, and they know one or two people who are willing to collaborate. Done. But once you've done that, you should follow through. It never works perfectly the first time, so you should have some sort of second design or an additional design report." – R13*

Wait for market before embracing circularity VS. Water boards should steer the market

Furthermore, a persistent tension revolves around the influence of the market in fostering circularity within the water board's operations. Certain employees within the water board advocate for a cautious approach, suggesting that they should wait for the market to mature and offer fully developed applications for dredged material before incorporating them into their procurement procedures. On the other hand, there are those who acknowledge their own capacity to act as catalysts in driving market development through their procurement decisions, effectively nudging contractors toward the adoption of circular practices. The quotations in table 17 exemplify this tension. On the one hand, some respondents take a passive stance, expecting the market to lead, whilst others claim the exact opposite.

This tension underscores the ongoing debate regarding the balance between market-driven change and the proactive role that water boards can adopt in shaping and accelerating market development. It prompts questions about whether the water board should primarily respond to market developments or proactively influence the market's trajectory by setting the standards and expectations for circular practices.

The debate within water boards on whether to passively wait for the market to develop circular solutions for dredged material or to proactively drive such market developments encapsulates a strategic and philosophical intersection. This tension mirrors the complex web of stakeholder interactions that was described in the previous chapter, where each entity within the dredging ecosystem operates within a defined scope, guided by established norms and practices. This current debate is not merely about choosing between passivity and proactivity but reflects a broader discussion on the role and identity of water boards within the dredging ecosystem. Historically, water boards may have operated within a reactive framework, conforming to market offerings and adjusting their practices based on available technologies and services. However, the urgency for sustainability and circularity in resource management is prompting a reassessment of this stance.

Taking a passive approach and waiting for market developments can seem like a lower-risk strategy that benefits from the industry's collective intelligence and innovation. Yet, this may lead to a slower pace of change, potentially causing water boards to fall behind in sustainability efforts and miss out on the opportunity to influence the market in a direction that aligns with their specific needs and values. Conversely, choosing to actively shape the market implies that water boards must step into a more visionary role, one that involves risk-taking and leadership. This proactive approach would not only demand a departure from their traditional roles but also require them to engage in new activities such as setting ambitious procurement standards, investing in research and development, and perhaps even partnering with or funding innovators in the dredging and material processing sectors. It suggests a fundamental shift in their operational paradigm, from being rule-followers to rule-makers, from being consumers of market solutions to being architects of market transformation.

The tension between these approaches is indicative of a deeper discursive struggle over how water boards perceive their agency in the transition to circularity. It brings to the forefront questions about the balance of power, responsibility, and initiative among stakeholders in the dredging ecosystem. On one side of the discourse, there is a cautious acknowledgment of the risks and uncertainties involved in trying to steer market developments; on the other side, there is a growing recognition that such leadership may be necessary to achieve the desired outcomes in sustainability and circularity.

Table 17. Example quotations tension "passive versus active stance towards market"

#	Example Quotation	
	Wait for market before embracing circularity	Water boards should steer the market
1	*"The market needs to figure it out on its own." – R6*	*"Questions like what do you [the market] see, what can you do, and maybe we should give them some suggestions in that regard." – R1*
2	*"Well, right now, I think it should just be up to the market." – R10*	*"So, our role is asking the market for it. […] The need for innovation then arises within the market." – R13*

Focus on CO2 reductions VS. Embrace circular use of dredged material

Additionally, within the water boards, there is a notable tension in the ongoing discourse, where on the one hand there is a heightened emphasis on CO2 reduction as a top priority, and on the other hand there is emphasis on the concept of circularity. The tension becomes particularly pronounced when considering the practical implementation of circularity in the context of dredged material. Circular practices introduce intricacies, primarily evident in the procurement processes. These processes are designed with a traditional, linear mindset, which doesn't always align seamlessly with the demands of circularity. For example, given that circularity is not yet effectively measured due to the absence of a clear definition, it hinders the ability to estimate how well the water boards are currently progressing in incorporating circular principles into their practices. Consequently, some within the organization shift their focus towards emissions reduction as a more accessible and immediate goal. Initiatives such as the adoption of electric vehicles for dredging operations are seen as tangible steps toward reducing the organization's carbon footprint.

It is essential to recognize that, despite the widespread acknowledgment of the importance of circularity, the precise "how" of its implementation remains complicated and unclear for many employees. Circular use of dredged material, especially in products like construction materials, requires employees to look beyond their own organization. The product derived from dredged material may not contribute to a closed chain within the organization, but it can significantly reduce reliance on primary resources for construction, for example. Also, emissions could potentially increase due to the transportation to processing locations, as opposed to keeping them within the local area. This complexity contributes to a sense of uncertainty regarding the best course of action (see quotation 1 in table 18 for an example quotation).

Consequently, it also appears that some employees promote options that prioritize the reduction of emissions as the most circular approach, primarily due to its practical manageability. Typically, this choice involves depositing dredged material on adjacent plots/ onshore, because it serves as land elevation, yet it eliminates the need for transportation too and, consequently, reduces emissions. Quotations 2 and 3 exemplify this confusion. In essence, the organization is at a crossroads, grappling with the challenge of striking the right balance between reducing carbon emissions and embracing circular practices to promote long-term sustainability.

The competition between the focus on CO2 reductions and the pursuit of circularity reflects a discursive intersection where water boards must balance immediate, quantifiable environmental goals with the longer-term, systemic benefits of circular practices. The prioritization of CO2 reductions can be seen as a direct response to the global urgency to address climate change, which often demands measurable and immediate actions. CO2 emissions can be quantified, allowing for clear targets and progress tracking, which aligns well with the traditional regulatory focus that favors concrete, short-term achievements. This focus is understandable and justified, given the critical importance of reducing greenhouse gas emissions to mitigate climate change impacts.

Circularity, however, represents a broader environmental philosophy that encompasses not only emissions reductions but also resource efficiency, waste minimization, and the creation of closed-loop systems that can sustainably support economic and ecological well-being. While the concept of circularity is gaining traction, it is often seen as more abstract and complex than the straightforward

goal of cutting CO2 emissions. Circularity requires a rethinking of material flows, product design, consumption patterns, and waste management—issues that are systemic and intertwined with many aspects of the dredging ecosystem.

Circularity challenges the traditional regulatory focus, which tends to be compartmentalized and prescriptive, by demanding an integrated approach that considers the entire lifecycle of materials and their environmental impact. This holistic view often requires new frameworks for evaluation, new forms of collaboration across the value chain, and the development of innovative technologies and practices. The transition to a more circular approach within the dredging industry is further complicated by the need to align with existing regulatory frameworks that may not have been designed with circularity in mind. These frameworks often emphasize “clean-up” solutions and may not incentivize or even accommodate the upstream changes that circularity advocates for, such as material reuse or the redesign of processes to eliminate waste from the outset.

Table 18. Example quotations tension “co2 vs circularity”

#	Example Quotation
1	*"Because if we start dredging in a ‘circular’ manner, but the CO2 emissions become significantly higher in the entire process, then it won't be as beneficial." – R1*
2	*"Onshore is simply the most circular thing you can imagine.” – R5*
3	*“In fact, we currently view placing dredged material onshore as the most sustainable and circular solution, as it requires significantly fewer transportation movements." – R11*

Contradictions in personal perceptions

Finally, one significant tension in the discourse is the discrepancy between the water board employees’ perception on the need to become more circular and on the actions that are necessary. While there exists a general ambition for circularity, some employees struggle to translate this aspiration into concrete actions or plans, and therefore often contradicted themselves in their responses to interview questions or during discussions at gatherings. Initially, they frequently acknowledged their responsibility, but it later became evident that they took limited action, for example. Essentially, while they recognized their role in the transition and often displayed ambition, they approached the implementation of specific changes with caution. In interviews this became apparent as well. For example, quotation 1 in table 19 shows that R7 at first acknowledges their responsibility, whilst in the same conversation, they later deviate from this stance. Or for example R10 states that is important accept the possibility for things to go wrong when experimenting with new products and processes (see quotation 2 in table 19). Yet in the same conversation they claim that standardization is necessary, inhibiting the room for experimentation.

Against this background, it becomes evident that employees struggle with the transition towards circular use of dredged material. On one hand, they desire change, acknowledging its necessity and feasibility. Simultaneously, they exhibit apprehension and reluctance when it comes to letting go of their current practices.

The discrepancy between employees' personal beliefs in circularity and their actions is a manifestation of discursive dissonance that has significant implications for the transition to circular practices within water boards. On an individual level, many employees may understand and even be

passionate about the concept of circularity and its benefits for sustainability. They may personally endorse the shift toward more sustainable practices and recognize the need for change within the dredging industry. However, translating these personal convictions into collective organizational action is where the dissonance becomes apparent. The 'rules of the game'—the existing protocols, procedures, and institutional norms—act as a powerful force that shapes and often constrains individual behavior within the organization. These rules are not merely formal regulations but are also constituted by the ingrained habits, cultural understandings, and unwritten codes of conduct that dictate 'how things are done' within the water boards.

Table 19. Example quotations tensions "personal perceptions"

#	Example Quotation	
	Quotation 1 same respondent	Quotation 2 same respondent
1	*"We can simply provide prerequisites from our department. Like, 'Okay, this is how it should be done [with regards to circularity],' so we do have a steering role in that." – R7*	*"We are focused on how to remove the sediment from the ditches. Well, if it's out, it's good." – R7*
2	*"So, well, as a water board, you also have to take some action and be willing to do something about it. Be open to the possibility that it might go wrong at some point." – R10*	*"Naturally, we also want standardization. We don't want something different for every project, so we have a general program of requirements. Well, that's been there for a while, it also states that it [product from dredged material for example] should last for 50 years." – R10*

6.3. CONCLUSION

This chapter examined what patterns are evident in the discourse within water boards as they shift towards the circular use of dredged materials. The analysis reveals a multifaceted landscape of regularities that are deeply influenced by the historical and cultural context of the dredging industry. Firstly, a significant regularity observed is the dichotomy between the established 'rules of the game' and the emerging principles of circularity. Texts and discourses within water boards consistently reflect a tension between the conservative nature of the dredging industry, which prioritizes stability and risk aversion, and the progressive ideology of circularity, which necessitates innovation and a departure from traditional practices.

A significant regularity is the presence of both enabling and inhibiting factors within the discursive landscape. On the one hand, there is a discernible acknowledgment of the need for and benefits of circularity, as well as a growing intrinsic motivation among employees to pursue sustainable practices. On the other hand, these positive discourses are often counterbalanced by challenges such as organizational fragmentation, lack of a uniform definition of circularity, and resource constraints. These inhibiting factors highlight the complexity of transitioning within a system that is not inherently designed for circular practices.

The analysis also uncovers regular tensions in the narratives surrounding the transition to circularity. Key among these is the contrast between the safety and familiarity of pilot projects and the

uncertainty surrounding systemic implementation. This reflects a broader discursive struggle to reconcile the need for immediate, tangible environmental achievements (such as CO2 reduction) with the long-term, systemic benefits of circularity. Additionally, there is a notable discrepancy between the personal beliefs of employees in sustainability and the collective actions of their organizations, illustrating the difficulty in translating individual understanding and enthusiasm into institutional change. Employees within water boards often express a personal understanding of and commitment to sustainability and circular principles. However, this individual conviction frequently clashes with the collective practices of the organization, which are still anchored in traditional, linear approaches. This discrepancy underscores a discursive dissonance within the organization, reflecting a broader challenge in aligning personal values with entrenched institutional practices.

In conclusion, the regularities in texts and discursive practices identified in this chapter offer a comprehensive view of the dynamic and complex process of transitioning towards circular use of dredged material within water boards. The findings underscore the influence of historical, cultural, and institutional factors in shaping this transition, revealing a scenario where the path to sustainability and circularity is understood yet complicated by the legacy of established practices and norms. This complicated interplay of factors provides a nuanced understanding of the challenges and opportunities inherent in the water boards' journey towards a more circular and sustainable future.

7. INSTITUTIONALIZATION

Building on the previous chapter's exploration of textual and discursive regularities, this chapter advances the discussion by examining the degree to which these emergent narratives and practices around circularity are becoming institutionalized within water boards' operations. The chapter analyzes how the identified discursive tensions and the dichotomy between the traditional 'rules of the game' and the principles of circularity are reflected in the institutionalization process. It does so by evaluating to what extent regulative, normative, and cultural-cognitive rules related to the circular use of dredged material are institutionalized within the operations of water boards.

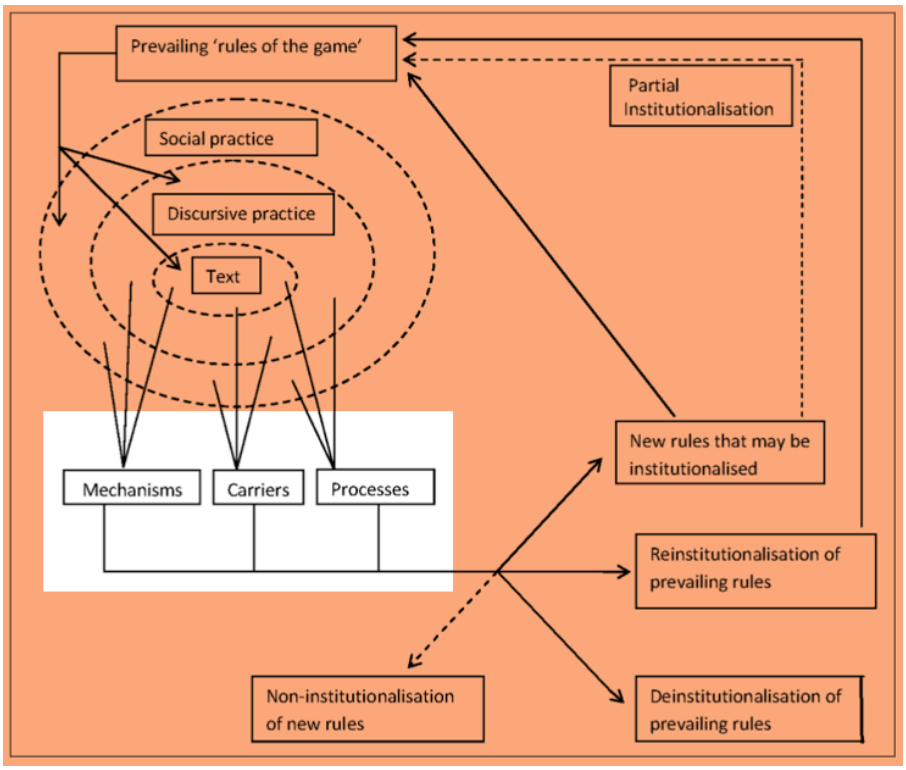

Figure 9. Discursive institutionalist approach to sustainability transitions – Mechanisms, Carriers, Processes. Taken from Genus (2014)

The key message of this chapter is that the water boards are currently in a state of transition towards the circular use of dredged material, negotiating the complex process of embedding new regulative, normative, and cultural-cognitive rules into their operations. While there is an evident commitment to circularity reflected in the policies and discourse, the actual practice is met with challenges stemming from the rigidity of existing rules, the fluidity of normative expectations, and a cultural narrative that traditionally favors risk aversion. The carriers of institutional change—symbolic systems, relational systems, routines, and artifacts—are actively evolving but have not yet fully integrated circular principles. The diffusion processes of habitualization, objectification, and sedimentation provide a framework to understand the extent of this integration, revealing a gradual shift towards circular practices that is yet to be firmly established across the organization. The transition is marked by a cautious approach as water boards balance the need for innovation with the security of established practices.

7.1. THE INSTITUTIONAL RULES AND THEIR MECHANISMS

This section delves into the analysis of institutional rules as they are manifested within the operations of water boards, particularly in the context of transitioning towards the circular use of dredged material. The examination is guided by the recognition of regulative, normative, and cultural-cognitive rules, each exerting its unique influence on the process of institutionalization (Genus, 2014).

Regulative Rules and Coercive Mechanisms: The regulative rules, encapsulated in legal and policy instruments, are the most overt and enforceable aspects of institutional rules. My analysis finds that these rules, strengthened by coercive mechanisms, are well-acknowledged within the water boards. The statutory targets for circularity are set and employees express a keen awareness of the need to align their practices with these targets. The enforcement of these rules through legal mandates ensures that there is a baseline level of compliance with the principles of circularity. However, the analysis also uncovers a rigidity within these regulative rules that can hinder flexibility and innovation. The lack of room for interpretation within these rules often leads to a check-box approach to compliance, which may not always align with the spirit of circularity that seeks transformative change beyond mere adherence to legal requirements.

Normative Rules and Normative Commitment Mechanisms: Normative rules, which dictate the expectations and obligations of conduct within water boards, are found to be in a state of motion. Employees demonstrate a multifaceted motivation toward circularity, indicating that while these rules are evolving, they are not yet firmly established. The analysis reveals a tension between employees' perceived responsibility to maintain orderly dredging operations and the growing expectation to actively engage in the modification of these practices towards circularity. There is a tangible sense of uncertainty as to how employees can or should contribute to the organization’s circularity goals, reflecting the shifting normative landscape. This uncertainty is further compounded by the absence of a universally accepted definition of circularity, leading to varied interpretations and applications of normative rules within the organization. Consequently, normative commitment mechanisms that would typically drive consistent behavior aligned with circularity goals are weakened, resulting in a less coherent collective movement towards circular practices.

Cultural-Cognitive Rules and Imitation Mechanisms: The cultural-cognitive rules are the most subtle yet pervasive influences on the institutionalization of circular practices within water boards. These rules form the backdrop against which new information is interpreted and new practices are judged. The analysis indicates that cultural-cognitive rules within water boards still largely reflect traditional values that prioritize stability and risk aversion. There is a notable emphasis on extrinsic motivations, such as compliance with regulations and managing excess dredged material, rather than intrinsic values of sustainability and circularity. This suggests that while there is an awareness of the need for circularity, it has not yet fully permeated the collective mindset as an accepted norm. Imitation mechanisms, which could potentially accelerate the adoption of circular practices, are hindered by this partial internalization of circular values. As a result, the transition towards circular practices is more gradual and cautious, mirroring the conservative cultural narrative within the industry.

In summary, the institutional rules and their mechanisms within water boards reveal a complex picture of transition towards the circular use of dredged material. Regulative rules, backed by coercive mechanisms, are acknowledged and guide compliance, yet they can sometimes repress innovation due to their inflexibility. Normative rules are actively evolving, with employees facing a tension between maintaining existing operations and adapting to new expectations for circularity, indicating a normative landscape that is still finding its new equilibrium. Cultural-cognitive rules, shaped by imitation mechanisms, show an awareness of the need for circular practices but are entrenched in a traditional attitude that favors risk aversion. This analysis indicates that the water boards are progressing towards circularity, although in a cautious manner, as they navigate through the intertwined layers of regulation, norms, and culture.

7.2. CARRIERS OF INSTITUTIONAL RULES: SYMBOLIC SYSTEMS, RELATIONAL SYSTEMS, ROUTINES, AND ARTIFACTS

Now that the institutional rules and their mechanisms have been identified, this section continues by examining the carriers that facilitate the embedding of the new institutional rules concerning the circular use of dredged material within the water boards. These carriers are the vehicles through which the principles of circularity are communicated, understood, and practiced in the daily operations of the organization.

Symbolic Systems: Symbolic systems act as linguistic and cognitive tools that enable the communication of the institutional rules (Genus, 2014). Within the water boards, symbolic systems, as reflected in policy documents and the language of organizational discourse, have begun to mirror the transition toward circularity. Analysis of the water boards' communications reveals a growing alignment with the set circularity goals and the intrinsic motivation for sustainability identified in the previous chapter. There is a notable shift in the language used, with terms like 'circular economy,' 'resource recovery,' and 'sustainability' becoming more prevalent. These terms are increasingly featured in internal and external communications, signaling a rhetorical commitment to circular practices. However, while the symbolic systems indicate an acknowledgment of circularity goals, the depth of their integration varies. Some documents and communications still reflect a cautious approach, suggesting that while the language of circularity is being adopted, it may not yet be fully embedded in the organizational identity.

Relational Systems: Relational systems define the web of relationships and interactions among different stakeholders within the organizations of water boards. In the context of the institutional rules, relational systems are instrumental in shaping the dynamics of normative rules (Genus, 2014). The relational systems within the water boards have shown a mixed level of adaptability to the new normative rules advocating for circularity. On one level, there is evidence of increased dialogue between different departments, indicating a move towards a more collaborative approach necessary for circular practices. However, this has not entirely overcome the fragmentation and ownership issues noted previously. While some teams show a strong commitment to cross-departmental collaboration, others remain siloed, indicating that the relational systems are still in transition. The power dynamics and interactions continue to evolve, with some employees taking on the role of circularity champions, advocating for change and striving to break down the barriers to collaboration.

Routines: Routines form an essential carrier of institutional rules, encompassing protocols, standard operating procedures, jobs, roles, obedience to duty, and scripts. These routines dictate the daily actions and behaviors of individuals within the water boards (Genus, 2014). The routines of water board employees are at the forefront of this analysis. There is a visible effort to integrate circular principles into daily operations, influenced by the learning initiatives and the growing will to innovate. For instance, some project teams have begun to introduce the idea of integrating circular criteria into procurement processes and are actively seeking out opportunities for the application of dredged materials in construction projects. However, the capacity constraints mentioned in the previous chapter remain a significant challenge. The routines associated with traditional practices are deeply entrenched, and while there is a willingness to adapt, the actual implementation is gradual and faces resistance due to competing priorities and limited resources.

Artifacts: Artifacts include physical objects that adhere to mandated specifications, conform to conventions and standards, or possess symbolic value. These tangible objects can play a role in reinforcing institutional rules and practices (Genus, 2014). Artifacts within the water boards, such as jars of separated dredged materials provided by the Circular Dredging Consortium (CBC), serve as tangible representations of circularity goals and are used to promote awareness and understanding of circular use. These artifacts play a role in reinforcing the shift towards circular practices, making the concept of circularity more tangible and relatable for employees. However, the presence of artifacts alone does not guarantee the institutionalization of new practices. While they are a step towards visualizing and conceptualizing circularity, their impact on daily operations and decision-making processes within water boards is less strong. For artifacts to effectively contribute to the institutionalization of circular practices, they must be integrated into the routines and relational systems that govern the actions and interactions within the organization. This is not the case.

In summary, the carriers of institutional rules within the water boards—symbolic systems, relational systems, routines, and artifacts—are all in a state of transition. They reflect both the progress made and the challenges that remain in embedding circularity within the organization. Symbolic systems are adapting but not yet fully transformed, relational systems are evolving but still confronting the inertia of traditional power structures, routines are shifting but at a slow pace, and artifacts are becoming more prominent but have not yet become central to the organizational ethos. Collectively, these carriers indicate an organization actively navigating the complex process of institutional change towards sustainable practices.

7.3. THE DIFFUSION PROCESSES

In the final analysis of this chapter, I turn to the diffusion processes—habitualization, objectification, and sedimentation—to understand how the circular use of dredged material is becoming a standard element within the operations of water boards. These processes, as depicted in Figure 9, are central to the institutionalization of the regulative, normative, and cultural-cognitive rules that have been dissected throughout this chapter.

Habitualization: Habitualization signifies the initial embedding of new practices within an organization, where they start to be seen as routine (Genus, 2014). In the context of the water boards, habitualization is reflected in the incremental adoption of circular practices in daily operations. There

is evidence that employees are increasingly incorporating circular goals into their work routines, signaling a growing recognition of these practices as standard. This shift begins to bridge the dichotomy between the conservative 'rules of the game' and the innovative principles of circularity. However, this process is not without its challenges.

The entrenched 'rules of the game'—the historical and cultural underpinnings of the water boards—have created a baseline that employees are reluctant to deviate from. While the emergence of circular practices is noted, the habitualization of these practices is inconsistent. Employees are often caught between adhering to the traditional practices that have served them well and embracing the new, circular methodologies that promise sustainability but require a departure from the familiar.

Objectification: Objectification marks the phase where the concept of circularity is articulated into concrete form, with strategies, plans, and policies (Genus, 2014). This research's analysis indicates that while there is a discursive commitment to circularity, its transition into operational policies and procedures is still in the early stages. The regulative rules provide clear targets, but the lack of a uniform definition of circularity leads to fragmented approaches to these targets. Initiatives like participating in the CBC are positive steps, creating platforms where circularity can be discussed and shaped into actionable strategies. However, there is still a gap between the policy rhetoric and the practical application of circular principles in everyday activities. The water boards are working toward objectifying circularity, but the process is gradual and requires further development to establish a cohesive and universally accepted approach.

Sedimentation: Sedimentation is the ultimate stage of institutionalization, where circular practices become the norm, deeply ingrained in the organization's identity (Genus, 2014). In the case of the water boards, there are signs that circularity is gaining ground. However, the sedimentation of these practices is far from complete. The traditional values of stability and risk aversion still have a significant influence within the cultural-cognitive landscape of the water boards. While circularity is increasingly recognized as important, it has not yet achieved the status of an unremarkable, standard operating principle across all levels of the organization. The challenges highlighted in the previous chapter — organizational fragmentation, competing priorities, and the need for a shared understanding of circularity — pose substantial barriers to the sedimentation process.

The presence of circular practices and discussions around them, such as the use of separated dredged materials in jars, indicates a move toward sedimentation, but these practices are not yet pervasive or consistent enough to be considered fully sedimented. The transformative change that sedimentation represents—a redefinition of the 'rules of the game'—is still emerging within the water boards. This process will likely require continued effort and a rethinking of both formal structures and informal cultural norms.

In summary, the diffusion processes—habitualization, objectification, and sedimentation—illustrate the gradual institutionalization of circular practices within the operations of water boards. Habitualization shows progress with employees incorporating circular goals into their routines, yet it confronts the slowness of historical 'rules of the game.' Objectification is underway, with circularity beginning to shape policies and actions, though it is hampered by the lack of a shared definition and cohesive approach. Sedimentation, the deepest level of embedding new practices, remains

incomplete, with circularity recognized in principle but not yet pervasive in practice. The transformative change required for full sedimentation is emerging but demands a continued effort to redefine both the formal and informal 'rules of the game' within the organizational culture of the water boards.

7.4. CONCLUSION

This chapter aimed to determine to what extent are regulative, normative, and cultural-cognitive rules related to the circular use of dredged material institutionalized within the operations of water boards. Concluding this chapter on institutionalization, it has become evident that while the water boards are in the midst of a transformative journey towards embedding circularity in their operations, the full institutionalization of these practices is still a work in progress. The discourse-institutional framework outlined by Genus (2014) has served as a valuable lens through which to view this transition, revealing the multifaceted nature of the institutionalization process.

The regulative, normative, and cultural-cognitive rules related to the circular use of dredged material are at varying stages of being absorbed into the water boards' operations. Coercive mechanisms have established a compliance baseline through regulative rules, yet these same mechanisms may inadvertently stifle the innovation necessary for a true paradigm shift. Normative rules are in flux, with employees grappling to reconcile their traditional roles with new expectations. Cultural-cognitive rules remain the bedrock of existing practices, and while they are gradually being influenced by the concept of circularity, there's still a considerable distance to cross before these new rules are deeply internalized as the norm.

The carriers of these institutional rules—symbolic systems, relational systems, routines, and artifacts—have begun to reflect this emerging paradigm, although to varying degrees. Symbolic systems, such as policy language and discourse, show a rhetorical shift towards circularity, but the depth of integration into organizational identity is variable. Relational systems have displayed a mixed adaptability to the new normative rules, with some departments embracing collaboration while others remain entrenched in silos. Routines are evolving, integrating circular criteria into procurement processes and operations, yet they are impeded by capacity constraints and the weight of traditional practices. Artifacts, as tangible embodiments of circularity, are fostering awareness but have yet to become a central aspect of the organizational ethos.

The diffusion processes of habitualization, objectification, and sedimentation highlight the nuances of this evolution. Habitualization is slowly taking place as circularity becomes part of the regular dialogue and activities within the water boards, reflecting a growing, yet uneven, recognition of its importance. Objectification, though in its nascent stages, is seeing circularity principles starting to shape organizational strategies and actions, striving to bridge the gap between the rhetoric of policy documents and the tangible implementation of circular practices. Sedimentation, as the most profound level of institutionalization, remains aspirational at this stage, with circular practices yet to be fully embraced as the 'new normal' within the water boards.

The transition towards circularity is unfolding against the backdrop of a conservative industry that is cautious by nature, presenting both challenges and opportunities for change. As water boards

continue to navigate this landscape, their journey underscores the complexity of institutional change—a process that is as much about altering formal structures as it is about shifting the cultural undercurrents that have long defined the industry. Accordingly, the journey towards institutionalizing circularity within water boards is marked by gradual progress and ongoing challenges. The transformative change required for full sedimentation is emerging, yet it will necessitate sustained efforts to redefine both the formal policies and the informal 'rules of the game' that shape the organizational culture.

8. CONCLUSION

This research has attempted to explore how water board actors navigate through, and shape, the transition towards circular use of dredged sediment. This chapter concludes with the research's main findings and aims, by means of the discussion, to provide a comprehensive interpretation of these findings. The chapter is significant for contextualizing the results within the broader framework of sustainability transitions, particularly focusing on the role of institutions. By critically examining the findings in light of existing literature, this chapter seeks to offer insights into the complexities, challenges, and implications of this transition. Additionally, this chapter provides suggestions for future research.

8.1. MAIN FINDINGS

This research critically examined the water boards' journey in the Netherlands towards the circular use of dredged sediment, set against the backdrop of ambitious targets for circularity. Water boards, carrying the majority of responsibility for regional dredging, must navigate the surplus of approximately 40 million cubic meters of dredged material annually, with the declining availability of disposal permits. This has made the pursuit of circular solutions an imperative. Despite the central role of water boards in managing dredged material, particularly in freshwater contexts, there has been a lack of empirical study on how these actors are navigating and shaping the transition towards the repurposing of this material. As they confront this challenge, Dutch water authorities have set forth bold targets: achieving 50% circularity by 2030 and reaching 100% by 2050.

It was established that understanding the discursive practices of water board actors is crucial to comprehending the complexities of this transition. The research question—*"How do water board actors navigate through and shape the transition towards circular use of dredged sediment?"*—opens an examination into the interplay between policy, practice, and the transformative goals set by the water boards. The urgency for a circular transition is clear, yet the specific path to achieving these targets remained a multifaceted puzzle. This study aimed to shed light on the intricate processes and practices involved. This section presents its main findings according to the three sub-research questions that organize the results sections.

8.1.1. "THE RULES OF THE GAME"

The first sub-question explored the fundamental norms and regulations that define the operational landscape of the dredging ecosystem in the Netherlands, with a particular focus on the role of water boards. The chapter focused on the rigorous regulatory environment that waterboard employees navigate, underscoring the complexity of their roles within the vast and interconnected dredging chain. The chapter detailed how these regulations orchestrate the interactions between the water boards and a multitude of stakeholders, ranging from government agencies to private contractors and environmental groups. This regulatory character not only dictates the operational parameters but also profoundly affects the strategic decisions made by the water boards. In addition, the chapter shed light on the entrenched conservatism of the dredging industry, a characteristic that is woven into the very fabric of its identity. This conservatism is manifest in a resistance to change and

a preference for time-tested methods and procedures, which has historically provided stability and reliability to the industry. However, I argued that this same resistance could present a formidable challenge when considering the implementation of innovative and sustainable practices. The regulatory and cultural frameworks are portrayed as integral to the water boards' operational identity, influencing every layer of their decision-making processes. The chapter thus set the groundwork for understanding how water boards operate within this interplay of strict governance and traditionalist mindsets. It painted a vivid picture of the industry's current state, preparing the reader to explore how these factors could interact with the evolving discourse on sustainability and the movement toward circular practices in the subsequent chapters.

8.1.2. TEXTUAL AND DISCURSIVE REGULARITIES

The second sub-question examined what regularities in texts and discursive practices came forward in the context of water boards transitioning towards circular use of dredged material. As proposed by Genus (2014), "[t]he governance of environmental sustainability is depicted as regularities in text and discursive practice." In examining the texts and discursive practices of water board employees amidst the shift towards circular use of dredged material, this chapter built upon the foundational insights previously discussed regarding the Dutch dredging industry's conservative nature and its dense network of stakeholder interactions. A central finding from this examination was the apparent tension between the longstanding 'rules of the game'—the industry's established norms and regulations—and the emerging principles of circularity. This tension manifested in the language and discourse emanating from the water boards, highlighting a duality where both enabling and inhibiting factors coexist. On one hand, there was a palpable acknowledgment of the need and potential benefits of adopting circularity, as well as an intrinsic motivation among employees to engage in sustainable practices. On the other hand, this progressive narrative was frequently countered by significant challenges such as organizational fragmentation, the lack of a universally accepted definition of circularity, and resource limitations—all of which complicated the transition to new circular practices in an industry traditionally not designed for such an approach.

The narrative of this transition was further characterized by a series of tensions. Notably, there was the comfort found in pilot projects, yet also acknowledgment of the necessity to scale these initiatives to a systemic level. This underscored a discursive struggle within the water boards to find a balance between achieving immediate environmental goals, like CO2 reduction, and striving for the long-term, systemic advantages that circularity promises. Additionally, the chapter highlighted a gap between the personal sustainability beliefs of individual employees and their actions, revealing a discursive conflict. This gap indicated the broader challenge of aligning personal values with the deeply rooted practices and norms of the organization. The chapter provided a comprehensive overview of the dynamic and intricate process that water boards face in transitioning towards the circular use of dredged material. It emphasized the significant impact of historical, cultural, and institutional factors in shaping this transition, painting a picture of a path to circularity that is acknowledged yet complicated by the weight of established practices. This complex interplay of factors offers a nuanced view of the challenges and opportunities inherent in the water boards' journey towards a more circular future.

8.1.3. INSTITUTIONALIZATION

Building on the previous chapter's exploration of textual and discursive regularities, the final results chapter advanced the research by examining the degree to which these emergent narratives and practices around circularity are becoming institutionalized within water boards' operations. The chapter showed that the interplay of institutional rules showcases a multifaceted transition towards the circular use of dredged material. Regulative rules provide a compliance framework, yet their rigidity can diminish innovative impulses. Normative rules are in a state of flux, with personnel caught between established protocols and emerging circularity standards, searching for a new balance. Cultural-cognitive rules are evolving; while there's a growing recognition of circularity's importance, prevailing attitudes still lean towards caution and familiar risk-averse practices.

The carriers of these institutional rules—encompassing symbolic systems, relational systems, routines, and artifacts—are evolving at different rates. Symbolic systems are adapting but not yet fully transformed, relational systems are evolving but still confronting the inertia of traditional power structures, routines are shifting but at a slow pace, and artifacts have not yet become central to the organizational ethos. In other words, the carriers are actively evolving but have not yet fully integrated circular principles. The diffusion processes of habitualization, objectification, and sedimentation provided a framework to understand the extent of this integration, revealing a gradual shift towards circular practices that is yet to be firmly established across the organization. It was concluded that the transition towards to circular use of dredged material is marked by a cautious approach as water boards balance the need for innovation with the security of established practices.

8.1.4. SYNTHESIS

The main research question that this research aimed to answer is the following: *How do water board actors navigate through, and shape, the transition towards circular use of dredged sediment?* In synthesizing the answers to the sub-questions, this research concludes with a nuanced recognition that the water boards are in a pivotal phase of transformation, navigating the deep-seated inertia of traditional practices to embrace the principles of circularity within their dredging operations. This delicate interplay between the steadfastness of tradition and the imperative for innovation reflects a landscape of institutional change that is advancing with cautious determination. Although progress is visible, the complete institutionalization of circular practices remains a complex endeavor, hindered by the rigidities of existing regulations, a culturally ingrained aversion to risk, and the absence of a cohesive circularity framework. In light of these findings, it becomes increasingly evident that the current rate of change may be insufficient to meet the ambitious targets of 50% circularity by 2030 and full circularity by 2050 set by Dutch water authorities. This study not only traces the outlines of this significant transition but also casts light on the broader challenges of environmental governance and the pathways to sustainability in complex institutional systems. The journey of the water boards exemplifies the resilience and the need for adaptive innovation necessary to overhaul entrenched systems.

8.2. DISCUSSION

This section discusses the theoretical and practical implications of the main findings and also offers recommendations.

8.2.1. THEORETICAL REFLECTIONS

In light of the main findings, the theoretical reflections of this research become particularly salient when considering the dynamic role of institutions in sustainability transitions. The study has illustrated that institutions like water boards are not only governed by formal structures such as policies and laws but are also deeply influenced by the norms and decision-making processes that govern the actions of individuals and groups within them. This complexity is critical in shaping both the trajectory and the efficacy of transitioning towards sustainable practices, like the circular use of dredged sediment.

The adapted theoretical framework from Genus (2014) offers a valuable lens through which the study's results can be interpreted, moving beyond the traditional Multi-Level Perspective (MLP) of sustainability transitions. This perspective acknowledges that institutions are composed of more than static structures; they are also formed by the discourses and interactions of individuals, who actively interpret and reshape rules and norms. For instance, in the water boards' shift toward circularity, we see Genus's framework in action as employees navigate the 'rules of the game'—they are not passive recipients of established norms but are agents of change, grappling with the complexities of integrating new practices within the dredging regime. This is evident in the way symbolic systems, relational systems, routines, and artifacts within water boards are in a state of transition. Symbolic systems, such as the language used in policies, are gradually adapting to incorporate circularity. However, as the results indicate, this change is not yet fully realized, illustrating the complex interplay between the existing institutional landscape and the agents working within it. The relational systems within water boards, characterized by the interactions between stakeholders, are also evolving. While some embrace the new normative expectations of circularity, others remain hindered by the inertia of traditional power structures. Routines are slowly shifting to integrate circular practices, reflecting a broader institutional adaptation to sustainability, albeit at a deliberate pace.

Furthermore, the study demonstrates the nuanced ways in which the diffusion processes of habitualization, objectification, and sedimentation are occurring within the water boards. The practices and ideas around circularity are becoming more routine (habitualization), starting to inform decision-making (objectification), but have not yet become deeply embedded as the standard approach (sedimentation). These stages highlight the incremental nature of institutional change and emphasize the pivotal role of agency in this transformation. By integrating Genus's (2014) framework into the analysis, the research provides a more nuanced understanding that captures the interplay between structural and agency factors. The findings underscore the significance of narratives and discourses within water boards that guide the behavior of their members. Such discourses can act as catalysts or barriers to sustainability, as evidenced by the water boards' cautious progression towards the ambitious circularity targets. The tensions and discursive struggles within these institutions demonstrate the active role individuals play in both interpreting sustainability goals and in the practical application of circular principles in their operations.

This study contributes to the broader discourse on environmental governance by highlighting the importance of considering both the formal institutional frameworks and the informal, discursive practices that shape them. It suggests that achieving sustainability in complex industrial ecosystems like dredging requires not just top-down policy initiatives or the adoption of new technologies but also a bottom-up reformation of institutional norms and practices driven by the agents within. The water boards' journey, as depicted in this research, exemplifies the resilience and adaptability required to transform entrenched systems and offers valuable insights for other institutions embarking on similar transitions towards sustainability.

Yet, while Genus's (2014) framework enriches the analysis of institutional dynamics in sustainability transitions, it is not without limitations. The model, by delineating distinct categories such as 'the rules of the game', discursive practices, and the process of institutionalization, might imply a more discrete separation between these elements than exists in practice. The study's findings suggest that in reality, these categories are intertwined and often overlap, with the boundaries between them being far from clear-cut.

For instance, 'the rules of the game'—which encompass the established norms and regulations—can also be seen as a product of ongoing discursive practices. The way individuals within water boards talk about and understand circularity directly influences how these 'rules' are perceived and followed. This is evident in the way that the conservative nature of the dredging industry, a deeply embedded cultural-cognitive rule, is both a backdrop to and an outcome of the discourses around risk and tradition. As such, the model might underrepresent the fluidity and interdependence between the rules and the discourses that continuously shape them. Similarly, the process of institutionalization does not stand apart from these 'rules' and discourses but is an emergent property of their interaction. The transition towards institutionalizing circular practices is not a linear progression but a complex negotiation where discourses can both challenge and reinforce existing rules. The stages of habitualization, objectification, and sedimentation are not always sequential or distinct but can occur simultaneously and in a cyclical manner, with shifts in discourse leading to changes in practice which then loop back to influence discourse.

Therefore, while Genus's framework provides a useful structure for understanding the role of institutions and agency in sustainability transitions, it may benefit from a more integrated approach that acknowledges the blurred lines between 'the rules of the game', discursive practices, and institutionalization. Such an approach would better capture the dynamism and complexity of the water boards' journey towards circularity, reflecting the reality of how these elements co-evolve and mutually inform each other. It would recognize that the discourses within water boards are not just a response to the existing rules but are part of an ongoing dialogue that continually reshapes what those rules signify and how they are enacted. The limitations of the model highlight the need for a more holistic understanding of institutional change, one that sees it as a continuous, iterative process rather than a series of discrete steps or phases. As one respondent puts it:

> *"It's like renovating a store, whilst the store is still open." – R10*

8.2.2. PRACTICAL IMPLICATIONS AND RECOMMENDATIONS

Drawing from this research's exploration into the transition towards the circular use of dredged sediment within Dutch water boards, my recommendation for a transformative approach is underpinned by the multifaceted nature of the challenge revealed in the findings. The research illustrated that water boards are poised in a delicate balance between entrenched regulatory frameworks, cultural norms, and the intricate demands of implementing circularity—a dance marked by both progress and hesitation.

The practical implications for the water boards necessitate a systemic and strategic approach, informed by the insights that surfaced through the research. Theory U and the Transition Arena emerge as potential methodologies to initiate change. Theory U, as proposed by Otto Scharmer (2018), emphasizes tapping into collective wisdom and learning from the emerging future. It offers a process of deep reflection and collective creativity. These reflective and co-creative stages could assist water boards in transcending current limitations and fostering innovative solutions, aligning with the research findings that highlighted a need for deeper understanding and redefinition of circular practices within the water boards (Scharmer, 2018). Similarly, the Transition Arena, a central element of the Transition Management framework, could provide a structured participatory process where a diverse group of stakeholders within the water boards convenes to challenge the status quo, envision alternative futures, and develop actionable pathways to achieve those visions. This method has the potential to break down entrenched practices and encourage more inclusive and adaptive water board practices. Despite the merits of Theory U and the Transition Arena, which include fostering participatory processes and collective foresight, these methodologies may not fully address the specific challenges and systemic needs of water boards. That is, they may lack the structural capacity to lead and coordinate the broad and sustained transformation that is required (Loorbach, 2007).

Therefore, I propose the establishment of a mission agency within water boards as the most compelling recommendation (Lindler et al., 2023). The concept of a mission agency was especially developed for the Federal Chancellery of Germany, which faces an increasing amount of challenges that require vast internal transitions. A mission agency is an organizational entity created within a government framework with a dedicated and specific focus on achieving ambitious, transformative goals—called "missions"—that address significant societal challenges. It operates with a mandate to lead, coordinate, and drive forward the strategies and actions necessary to realize these goals. A mission agency is well-suited to address the complexity of the transition to circularity, as it would have a mandate to orchestrate strategies and actions necessary to achieve circularity goals, acting as a central change agent and driving forward a cohesive circular agenda. Unlike the broader methodologies of Theory U and Transition Arena, a mission agency provides a targeted and authoritative approach to managing the circular transition, combining the agility needed for innovation with the authority to implement systemic changes.

A mission agency's work involves strategic visioning to articulate clear, measurable, and time-bound objectives; stakeholder mapping to understand and integrate the roles and interests of all parties involved; resource mobilization to secure the financial, human, and technical assets required; and capacity building to enhance the skills and knowledge of its own staff and wider network. Additionally, it engages in pilot and scaling projects to test approaches and strategies, employs political advocacy to

build support and navigate policy environments, develops comprehensive communication strategies to maintain public engagement and transparency, and sets up robust monitoring and evaluation mechanisms to track progress and adapt strategies as needed. In essence, a mission agency is an institutional instrument designed to catalyze and manage transformative change, targeting specific, high-priority societal challenges with a problem-solving orientation that is proactive, integrative, and aimed at creating lasting impact (Lindler et al., 2023).

The mission agency within the water boards would centralize efforts, aligning various stakeholders around shared objectives and ensuring that circular practices are institutionalized within the governance framework. This directly responds to the research findings that point to the necessity for a unified approach to overcome the fragmented and compartmentalized efforts currently observed. With its flexibility and innovation-oriented character, a mission agency would adeptly manage the shift towards circularity, navigating through the complexities revealed in the research, including the cultural inertia and regulatory rigidity. The agency would integrate the merits of both Theory U and the Transition Arena, fostering deep introspection and collective action, while also possessing the structural capacity to effect systemic changes. This would resonate with the research findings that show a clear recognition among water board employees of the need for circularity, coupled with the challenges they face such as organizational fragmentation and the absence of a universally accepted definition of circularity.

Through this research, I have demonstrated that the challenges water boards face, are not merely technical but are deeply embedded in institutional routines and cultures. The mission agency would actively address these cultural and systemic barriers, facilitating a transition that is as much about changing mindsets as it is about altering practices. It would be a strategic driver, fostering a culture where the principles of circular economy become ingrained within the decision-making and operational processes of the water boards. In implementing such agencies, it is crucial to design them with the capacity to engage in robust stakeholder mapping, strategic visioning, and resource mobilization. They should be equipped to handle pilot projects that experiment with circular practices, scale up successful initiatives, and foster political advocacy to navigate and shape the policy environment. Comprehensive communication strategies would be essential to maintain stakeholder engagement and public transparency throughout the transition process.

Taking into account the insights gained from working closely with the Circular Dredging Consortium (CBC), I believe that the water boards already benefited from participating in this initiative in a similar way as they would from a mission agency. The CBC functions similarly to a mission agency in driving organizational change, bringing together diverse stakeholders, with the mission to integrate circularity into their organizations. However, as an external entity, its influence on internal processes is naturally limited. And these internal processes are exactly what stifle the transition. An internal mission agency, on the other hand, would have the authority and proximity to effect change at the core of the water boards' operations, embedding circular principles into the very fabric of their institutional practices. It is my hope that the CBC's enthusiasm in initiating change and fostering a circular economy mindset could serve as a blueprint for the establishment of internal mission agencies in water boards.

In sum, the introduction of an internal mission agency as a strategic driver within water boards would be a robust entity with the authority and mandate to lead the shift towards a circular approach in

dredging operations, ensuring the water boards' journey towards circularity is both innovative and effectively implemented. Given the intricacies and pace of institutional change observed in this research, the ambitious 2030 targets (50%) for circularity seem unattainable at this juncture. Nonetheless, would a mission agency be realized soon, it would strategically position the water boards to progressively work towards the 2050 targets (100%).

8.3. SUGGESTIONS FOR FUTURE RESEARCH

This thesis serves as a foundation for future research. Building upon the outcomes of this research, future scholarly efforts could more intricately explore the interaction between institutional rules and individual agency, particularly given the theoretical limitations identified in Genus's (2014) framework. The assumption of a clear boundary between 'the rules of the game', discursive practices, and the process of institutionalization has been challenged by the findings that these aspects are deeply intertwined and mutually influential. Thus, a detailed investigation into the fluid dynamics that govern the interplay of individual actions and institutional structures is significant. A methodological approach that captures these real-time interactions could involve longitudinal case studies or participatory observation techniques, tracking policy development and enactment within water boards.

Additionally, this research has posited the novel concept of mission agencies within water boards as a practical solution to catalyze the transition toward circularity. However, the practicality and impact of such agencies within the established institutional frameworks remain largely speculative. Future studies may critically assess the operational challenges and long-term effectiveness of mission agencies in fostering sustainability transitions. Longitudinal studies, in particular, would be valuable in evaluating whether these entities can achieve their mandate to centralize efforts, align diverse stakeholder interests, and ensure the integration of circular practices into governance structures. Furthermore, the practical recommendation to establish mission agencies within water boards also calls for an in-depth analysis of how these organizations can balance innovation with existing operational practices. Considering the water boards' inclination towards risk aversion and regulatory compliance, research could focus on action-based strategies that navigate the complexities of embedding innovative circular practices while maintaining operational continuity. This approach would significantly benefit from participatory action research methods, which would allow for real-time experimentation and adaptation within water boards, providing insights into the management of change in institutional environments that are traditionally resistant to disruption.

In synthesizing these aspects, future research could aim to contribute not just to the theoretical discourse on sustainability transitions but also to the practical tools required for their realization. By intertwining the theoretical examination of institutions with the application of mission agencies, future research can offer critical insights into the successful management of the shift towards sustainable and circular practices. This dual focus would ensure that future studies not only advance academic understanding but also provide tangible benefits to practitioners navigating the complexities of environmental governance and institutional change. With a more elaborate examination of these areas, future research could strengthen the groundwork laid by this study and facilitate progress towards the ambitious circularity targets set for the coming decades.

BIBLIOGRAPHY

Ali, M. H., Zailani, S., Iranmanesh, M., & Foroughi, B. (2019). Impacts of Environmental Factors on Waste, Energy, and Resource Management and Sustainable Performance. *Sustainability*, *11*(8), Article 8. https://doi.org/10.3390/su11082443

Anney, V. N. (2014). Ensuring the quality of the findings of qualitative research: Looking at trustworthiness criteria. *Journal of Emerging Trends in Educational Research and Policy Studies*, *5*(2), 272–281.

Arreola, D., Hernandez, J., Vesco, V., & Reddy, K. R. (2022). Dredged Material Decision Tool (DMDT) for Sustainable Beneficial Reuse Applications. *Journal of Marine Science and Engineering*, *10*(2), Article 2. https://doi.org/10.3390/jmse10020178

Ayres, R., & Ayres, L. (2002). A Handbook of Industrial Ecology. In *A Handbook of Industrial Ecology* (Vol. 10). Edward Elgar Publishing. https://www.elgaronline.com/view/1840645067.xml

Baggerproblematiek in Nederland. (2009). Compendium Voor de Leefomgeving. https://www.clo.nl/indicatoren/nl021005-baggerproblematiek-in-nederland

Baldassarre, B., Schepers, M., Bocken, N., Cuppen, E., Korevaar, G., & Calabretta, G. (2019). Industrial Symbiosis: Towards a design process for eco-industrial clusters by integrating Circular Economy and Industrial Ecology perspectives. *Journal of Cleaner Production*, *216*, 446–460. https://doi.org/10.1016/j.jclepro.2019.01.091

Barbour, R., & Schostak, J. (Eds.). (2005). Interviewing and Focus Groups. In *Research methods in the social sciences* (pp. 41–48). SAGE Publications.

Berndt, A. E. (2020). Sampling methods. *Journal of Human Lactation*, *36*(2), 224–226.

Besseling, E., Sittoni, L., & Janssen, S. (2019). *Onderzoek circulair gebruik van baggerspecie bij de waterschappen*. Deltares. https://www.netics.nl/wp-content/uploads/2022/03/Onderzoek-circulair-gebruik-van-baggerspecie-bij-de-waterschappen.pdf

Besseling, E., Volbeda, E., Koster, J., Sittoni, L., & Van Zelst, V. (2020). *Circulair baggerbeheer. Een toetsingsinstrument om circulair om te gaan met regionale bagger* (RWS 31158004.0008). Rijkswaterstaat. https://www.bodemplus.nl/onderwerpen/bodem-ondergrond/bodemconvenant/thema/kennis/uitvragen/@241483/circulair-baggerbeheer/

Bianchi, M., & Cordella, M. (2023). Does circular economy mitigate the extraction of natural resources? Empirical evidence based on analysis of 28 European economies over the past decade. *Ecological Economics*, *203*, 107607. https://doi.org/10.1016/j.ecolecon.2022.107607

Bilgen, G., & Altuntas, O. F. (2023). Sustainable re-use of waste glass, cement and lime treated dredged material as pavement material. *Case Studies in Construction Materials*, *18*, e01815. https://doi.org/10.1016/j.cscm.2022.e01815

Bosman, R. (2022). *Into Transition Space: Destabilisation and incumbent agency in an accelerating energy transition*.

Bours, S., Swartjes, J., & Hekkert, M. (2022, October). *Transitie naar een circulaire grond-, weg- en waterbouw: Een missie-gedreven innovatie systeem analyse* [Report]. Utrecht University. https://doi.org/10.5281/zenodo.7273685

Bouwens, B., & Sluyterman, K. (2011). *Longevity in regional specialization: The Dutch dredging industry*. EBHA Conference, Athens, Athens. https://ebha.org/ebha2011/files/Papers/paper%20Sluyterman%20and%20Bouwens-Athens%202011.pdf

Bouwens, B., & Sluyterman, K. E. (2010). *Verdiept verleden: Een eeuw Koninklijke Boskalis Westminster en de Nederlandse baggerindustrie*. Boom.

Braun, V., & Clarke, V. (2021). To saturate or not to saturate? Questioning data saturation as a useful concept for thematic analysis and sample-size rationales. *Qualitative Research in Sport, Exercise and Health*, *13*(2), 201–216.

Breeman, G. E., Van Noort, W. J., & Rutgers, M. R. (2012). *De Bestuurlijke kaart van Nederland. Het openbaar bestuur en zijn omgeving in nationaal en internationaal perspectief (5e herz. Druk)*. Coutinho.

Brils, J., de Boer, P., Mulder, J., & de Boer, E. (2014). Reuse of dredged material as a way to tackle societal challenges. *Journal of Soils and Sediments*, *14*(9), 1638–1641. https://doi.org/10.1007/s11368-014-0918-0

Brown, R. R., Farrelly, M. A., & Loorbach, D. A. (2013). Actors working the institutions in sustainability transitions: The case of Melbourne's stormwater management. *Global Environmental Change*, *23*(4), 701–718.

Chandrasegaran, S., Badam, S., Kisselburgh, L., Ramani, K., & Elmqvist, N. (2017). Integrating Visual Analytics Support for Grounded Theory Practice in Qualitative Text Analysis. *Computer Graphics Forum*, *36*. https://doi.org/10.1111/cgf.13180

Chun Tie, Y., Birks, M., & Francis, K. (2019). Grounded theory research: A design framework for novice researchers. *SAGE Open Medicine*, *7*, 2050312118822927. https://doi.org/10.1177/2050312118822927

Collier, Z. A., Bates, M. E., Wood, M. D., & Linkov, I. (2014). Stakeholder engagement in dredged material management decisions. *Science of The Total Environment*, *496*, 248–256. https://doi.org/10.1016/j.scitotenv.2014.07.044

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, *13*(1), 3–21. https://doi.org/10.1007/BF00988593

Crocetti, P., González-Camejo, J., Li, K., Foglia, A., Eusebi, A. L., & Fatone, F. (2022). An overview of operations and processes for circular management of dredged sediments. *Waste Management*, *146*, 20–35. https://doi.org/10.1016/j.wasman.2022.04.040

de Haan, F. J., & Rotmans, J. (2018). A proposed theoretical framework for actors in transformative change. *Technological Forecasting and Social Change*, *128*, 275–286. https://doi.org/10.1016/j.techfore.2017.12.017

Directorate-General for Communication (European Commission). (2020). *Circular economy action plan: For a cleaner and more competitive Europe*. Publications Office of the European Union. https://data.europa.eu/doi/10.2779/05068

Farla, J., Markard, J., Raven, R., & Coenen, L. (2012). Sustainability transitions in the making: A closer look at actors, strategies and resources. *Technological Forecasting and Social Change*, *79*(6), 991–998. https://doi.org/10.1016/j.techfore.2012.02.001

Fischer, L.-B., & Newig, J. (2016). Importance of Actors and Agency in Sustainability Transitions: A Systematic Exploration of the Literature. *Sustainability*, *8*(5), Article 5. https://doi.org/10.3390/su8050476

Fuenfschilling, L., & Truffer, B. (2016). The interplay of institutions, actors and technologies in socio-technical systems—An analysis of transformations in the Australian urban water sector. *Technological Forecasting and Social Change*, *103*, 298–312.

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40. https://doi.org/10.1016/j.eist.2011.02.002

Geels, F. W. (2019). Socio-technical transitions to sustainability: A review of criticisms and elaborations of the Multi-Level Perspective. *Current Opinion in Environmental Sustainability*, *39*, 187–201. https://doi.org/10.1016/j.cosust.2019.06.009

Genus, A. (2014). Governing Sustainability: A Discourse-Institutional Approach. *Sustainability*, *6*(1), Article 1. https://doi.org/10.3390/su6010283

Genus, A. (2016). Sustainability Transitions: A Discourse-institutional Perspective. In H. G. Brauch, Ú. Oswald Spring, J. Grin, & J. Scheffran (Eds.), *Handbook on Sustainability Transition and Sustainable Peace* (pp. 527–541). Springer International Publishing. https://doi.org/10.1007/978-3-319-43884-9_24

Giacobbi, P. R., Poczwardowski, A., & Hager, P. (2005). A Pragmatic Research Philosophy for Sport and Exercise Psychology. *The Sport Psychologist*, *19*(1), 18–31. https://doi.org/10.1123/tsp.19.1.18

Gibbs, D., & Deutz, P. (2007). Reflections on implementing industrial ecology through eco-industrial park development. *Journal of Cleaner Production*, *15*(17), 1683–1695. https://doi.org/10.1016/j.jclepro.2007.02.003

Grafström, J., & Aasma, S. (2020). *Breaking Circular Economy Barriers*. https://doi.org/10.13140/RG.2.2.12383.48809

Heise, S., Babut, M., Casado, C., Feiler, U., Ferrari, B. J. D., & Marziali, L. (2020). Ecotoxicological testing of sediments and dredged material: An overlooked opportunity? *Journal of Soils and Sediments*, *20*(12), 4218–4228. https://doi.org/10.1007/s11368-020-02798-7

Hét Circulaire Bagger Consortium. (n.d.). Waterweg. Retrieved August 29, 2023, from https://www.waterweg.co/cbc

Kawulich, B. B. (2005). Participant Observation as a Data Collection Method. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, *6*(2), Article 2. https://doi.org/10.17169/fqs-6.2.466

Lindler, R., Wittmann, F., Jackwerth-Rice, T., Daimer, S., Edler, J., & Posch, D. (2023). Deutschland transformieren: Missionsagenturen als innovativer Baustein zur Bewältigung gesamtgesellschaftlicher Herausforderungen. *Bertelsmann Stiftung*, *1*, 1–36. https://doi.org/10.11586/2022146

Loorbach, D. (2007). *Transition Management: New mode of governance for sustainable development*. https://repub.eur.nl/pub/10200/

Loorbach, D., Frantzeskaki, N., & Avelino, F. (2017). Sustainability Transitions Research: Transforming Science and Practice for Societal Change. *Annual Review of Environment and Resources*, *42*(1), 599–626. https://doi.org/10.1146/annurev-environ-102014-021340

Loorbach, D., & Rotmans, J. (2010). The practice of transition management: Examples and lessons from four distinct cases. *Futures*, *42*(3), 237–246. https://doi.org/10.1016/j.futures.2009.11.009

Mertens, D. M., & Hesse-Biber, S. (2012). Triangulation and mixed methods research: Provocative positions. In *Journal of Mixed Methods Research* (Vol. 6, Issue 2, pp. 75–79). Sage Publications Sage CA: Los Angeles, CA.

Ministerie van Infrastructuur en Waterstaat. (2023a). *Baggerdepots* [Webpagina]. http://www.rijkswaterstaat.nl/water/waterbeheer/beheer-en-ontwikkeling-rijkswateren/baggeren/baggerdepots

Ministerie van Infrastructuur en Waterstaat. (2023b). *Baggeren* [Webpagina]. http://www.rijkswaterstaat.nl/water/waterbeheer/beheer-en-ontwikkeling-rijkswateren/baggeren

Musante, K., & DeWalt, B. R. (2010). *Participant Observation: A Guide for Fieldworkers*. Rowman Altamira.

Paipai, E. (2003). *Beneficial uses of dredged material: Yesterday, today and tomorrow*. 3–12.

Pearce, D. W., & Turner, R. K. (1989). *Economics of Natural Resources and the Environment*. JHU Press.

Pesch, U. (2015). Tracing discursive space: Agency and change in sustainability transitions. *Technological Forecasting and Social Change*, *90*, 379–388. https://doi.org/10.1016/j.techfore.2014.05.009

Platform WOW. (2023). *Over Platform WOW | Platform WOW*. https://platformwow.nl/over-platform-wow

Popescu, C., Hysa, E., Kruja, A., & Mansi, E. (2022). Social Innovation, Circularity and Energy Transition for Environmental, Social and Governance (ESG) Practices—A Comprehensive Review. *Energies*, *15*(23), Article 23. https://doi.org/10.3390/en15239028

Radjenovic, D., Kerkez, D., Tomašević Pilipović, D., Dubovina, M., Seslija, M., Tenodi, S., & Pesko, I. (2023). *Long Term Assessment for Sustainable Sediment Management Strategy: S/S Treatment of Polluted Sediment with Fly Ash and Lime* (SSRN Scholarly Paper 4363423). https://doi.org/10.2139/ssrn.4363423

Rauschmayer, F., Bauler, T., & Schäpke, N. (2015). Towards a thick understanding of sustainability transitions—Linking transition management, capabilities and social practices. *Ecological Economics*, *109*, 211–221. https://doi.org/10.1016/j.ecolecon.2014.11.018

Scharmer, O. (2018). *The essentials of Theory U: Core principles and applications*. Berrett-Koehler Publishers.

Schmidt, V. (2008). Discursive Institutionalism: The Explanatory Power of Ideas and Discourse. *Annual Review of Political Science*, *11*. https://doi.org/10.1146/annurev.polisci.11.060606.135342

Schmidt, V. (2010). Taking ideas and discourse seriously: Explaining change through discursive institutionalism as the fourth 'new institutionalism.' *European Political Science Review*, *2*(1), 1–25. https://doi.org/10.1017/S175577390999021X

Schmidt, V. (2015). Discursive Institutionalism: Understanding Policy in Context. In *Handbook of Critical Policy Studies*. Edward Elgar Publishing. https://doi.org/10.4337/9781783472352

Scholz, R. W., & Binder, C. R. (2011). *Environmental Literacy in Science and Society: From Knowledge to Decisions*. Cambridge University Press.

Scott, W. R. (2003). Institutional carriers: Reviewing modes of transporting ideas over time and space and considering their consequences. *Industrial and Corporate Change*, *12*(4), 879–894. https://doi.org/10.1093/icc/12.4.879

Scott, W. R. (2008a). Approaching adulthood: The maturing of institutional theory. *Theory and Society*, *37*, 427–442.

Scott, W. R. (2008b). *Institutions and organizations: Ideas and interests*. Sage.

Searle, J. R. (1995). *The Construction of Social Reality*. Free Press.

Sittoni, L., Boer, J., van der Star, W., Heuvel, M., Baptist, M., van Eekelen, E., Groot, F., Nieboer, H., & Doets, I. (2019). *Beneficial and nature-based sediment use-experiences from Dutch pilots*.

Spradley, J. P. (2016). *Participant Observation*. Waveland Press.

Unie van Waterschappen. (2023). Over de Unie. *Unie van Waterschappen*. https://unievanwaterschappen.nl/over-de-unie/

Uyarra, E., Zabala-Iturriagagoitia, J. M., Flanagan, K., & Magro, E. (2020). Public procurement, innovation and industrial policy: Rationales, roles, capabilities and implementation. *Research Policy*, *49*(1), 103844. https://doi.org/10.1016/j.respol.2019.103844

van der Meulen, M. J., van der Spek, A. J. F., de Lange, G., Gruijters, S. H. L. L., van Gessel, S. F., Nguyen, B.-L., Maljers, D., Schokker, J., Mulder, J. P. M., & van der Krogt, R. A. A. (2007). Regional Sediment Deficits in the Dutch Lowlands: Implications for Long-Term Land-Use Options (8 pp). *Journal of Soils and Sediments*, *7*(1), 9–16. https://doi.org/10.1065/jss2006.12.199

van Rijswick, M. (2014). *Vijf jaar Waterwet: Van vraag tot antwoord: Nieuwe vragen en antwoorden over de praktijk van de Waterwet*. Ministerie van Infrastructuur en Waterstaat.

Wat is Baggernet? (2023). Baggernet Online. https://www.baggernet.info/wat-is-

Waterbodembeleid en baggeren. (n.d.). *Unie van Waterschappen*. Retrieved August 31, 2023, from https://unievanwaterschappen.nl/waterkwantiteit/waterbodembeleid-en-baggeren/

Wittmayer, J. M., Avelino, F., van Steenbergen, F., & Loorbach, D. (2017). Actor roles in transition: Insights from sociological perspectives. *Environmental Innovation and Societal Transitions*, *24*, 45–56. https://doi.org/10.1016/j.eist.2016.10.003

Yin, R. K. (1998). The abridged version of case study research. *Handbook of Applied Social Research Methods*, *2*, 229–259.

Zucker, D. M. (2009). How to Do Case Study Research. In *Teaching Research Methods in the Social Sciences* (2nd ed., p. 17). University of Massachusetts Amherst. https://scholarworks.umass.edu/nursing_faculty_pubs/2

APPENDIX A: INTERVIEW QUESTIONS - INTERVIEWS CONDUCTED BY CBC

Interview question guide CBC – employees interviews water boards and *Unie van Waterschappen*

Topic	Questions
Current Scenario	- If applicable to the respective water board, can you retrieve data about the sediment with the current Sankey diagram[5] classifications?
	- How do you explain the gap between polluted sediment dredged and the amount eventually disposed of?
	- Are there any applications for the sediment that we're not aware of?
	- Can you provide data on these applications?
	- Do the applications mentioned in the Sankey apply to your water board?
	- Can you quantify these applications? Why or why not?
Circularity	- How circular is your organization, and is this reflected in the Sankey?
	- Who determines whether the applications in the Sankey are circular?
	- Is there a specific circularity definition you use? If yes, where can we find it?
	- Does your organization have a vision for achieving circularity, potentially in a step-by-step plan?
	- If so, who authored this plan, and where can it be accessed?
Future Scenario	- What is your definition of when dredging/the dredging chain is circular?
	- What guidelines and measurement methods are used to track/measure circularity?
	- Who will decide where the sediment goes in a competitive scenario?
	- Which current applications do you consider circular and worth continuing in the future?
	- Do you foresee these applications remaining the same, increasing, or decreasing in the future?
	- Do you expect the dredging flow to remain constant?
	- Will the distribution between applicable and non-applicable sediment remain the same in the future?
	- Will the sediment become cleaner or dirtier in the future?
Processing Steps	- What processing steps for dredged sediment (e.g., drying, dewatering, separation) have you encountered?
	- What are the names of these processing methods?
Bottlenecks	- Do you recognize the bottlenecks identified based on quarterly session 2? How can they be addressed to engage stakeholders?
	- Could you provide insights into why certain bottlenecks remain unresolved?
	- Please select the top 3 bottlenecks most relevant to your organization.

[5] The Circular Dredging Consortium (CBC) has initiated a quantitative assessment using Sankey diagrams to depict different dredged material streams. These diagrams illustrate the existing situation as well as a projected future scenario, mapping out the pathways and transformations of these material flows. By quantifying and visually representing the movement of dredged materials, the CBC seeks to offer a clear grasp of current usage patterns while envisioning their optimized and sustainable repurposing in a circular manner.

	- Additionally, select 3 bottlenecks where you believe you can contribute to the solution and describe how.
Baggernetdag (Dredge Network Day)	- Will you attend the Dredge Network Day on September 25th? What are your expectations for the event?
	- Who should participate in the valorization options market? Who is already involved in valorizing sediment?
Personalized Sankey	- Would it be valuable for your organization to have a Sankey based solely on your data?
	- Are you interested in a personalized Sankey for your current dredging, vision implementation, and future scenarios?

APPENDIX B – INTERVIEW PROTOCOL - INTERVIEWS CONDUCTED BY THE AUTHOR OF THIS RESEARCH

Interview protocol for interviews with water boards employees.

Introductie

- Bedanken voor tijd en medewerking.
- Hoe deze sessie eruitziet:
    - Introductie van het onderzoek
    - Instemmingsformulier samen doornemen + ondertekenen
    - Start audio-opname? → Toestemming vragen
    - Algemenere vragen
    - Inhoudelijke vragen
    - Afronding interview
- Laat weten: tussendoor altijd ruimte voor vragen en opmerkingen
- Alles duidelijk?

Introduceren van het onderzoek en het interview

- Context van onderzoek
    - Masterscriptie Industriële Ecologie aan Universiteit Leiden en TU Delft.
- Focus van onderzoek
    - Waterschappen in de overgang naar circulair gebruik van baggerspecie.
    - Waarom waterschappen? → Dragen grootste verantwoordelijkheid voor baggeren van regionale wateren.
- Doel onderzoek
    - Dit onderzoek richt zich op: Hoe waterschap medewerkers navigeren door de overgang naar het circulaire gebruik van bagger en hoe ze deze overgang vormen.
    - Om de complexiteit van deze overgang te begrijpen en empirische inzichten te verwerven, is een gedetailleerd onderzoek naar de discursieve praktijken die worden gebruikt door medewerkers van waterschappen significant. (*Extra uitleg: Hoe praten zij over dit thema? Wat vinden ze van de transitie? Hoe ervaren zij het?*) Puttend uit praktijken en ervaringen in de echte wereld draagt dit empirische onderzoek bij aan een breder begrip van hoe regionaal bestuur transities vormgeven, met name in de context van circulair gebruik van bagger. De focus van dit onderzoek ligt op drie waterschappen: *Hoogheemraadschap Schieland en de Krimpenerwaard*, *Waterschap Hollandse Delta* en *Hoogheemraadschap Rijnland*. Deze waterschappen dienen als een boeiende casestudy vanwege hun deelname en financiële bijdragen aan een gezamenlijke inspanning gericht op het transformeren van de baggerindustrie: het Circulair Bagger Consortium (CBC).
    - De vragen in dit interview zullen gericht zijn op een van mijn sub-onderzoeksvragen: ***Welke regelmatigheden in teksten en discursieve praktijken komen naar voren in de context van waterschappen die overgaan naar circulair gebruik van baggerspecie?***

- Vragen of opmerkingen over het onderzoek of het interview?

Doornemen 'informed consent' formulier:

- Formulier doornemen
- Vragen of opmerkingen over het formulier?
- Toestemming vragen audio-opname

[*AUDIO-OPNAME STARTEN*]

Thema	Vragen
Algemeen	Kunt u uitleggen wat uw verantwoordelijkheden zijn binnen het waterschap? o Hoe ziet een normale werkdag eruit?
	Hoe zou u de huidige praktijken voor baggerwerkzaamheden binnen uw waterschap beschrijven?
Circulariteit	Wat is volgens u circulair gebruik van baggerspecie?
	Wat vindt u van de overgang naar circulair gebruik van baggerspecie?
	Wat zijn de belangrijkste drijfveren of redenen achter de overgang naar het circulaire gebruik van baggerspecie volgens u?
	Welke economische en milieubaten (voordelen) verwacht u van de overgang naar circulaire praktijken voor baggerspecie?
	Wat zijn de belangrijkste uitdagingen of obstakels bij de overgang naar circulair gebruik van baggerspecie? o Kunt u hier voorbeelden van geven?
	Wie is volgens u verantwoordelijk voor de overgang naar circulair gebruik van baggerspecie? o Waarom?
	Wat zijn de toekomstige doelen en mijlpalen voor uw waterschap met betrekking tot de bevordering van het circulaire gebruik van baggerspecie?
	Wat zijn de indicatoren die worden gebruikt om de voortgang en impact van circulaire praktijken voor baggerspecie binnen uw waterschap te meten? (Als ze er zijn?)
	Wat zijn volgens u de belangrijkste factoren die het succes van de overgang naar het circulaire gebruik van baggerspecie in uw waterschap zullen bepalen?
	Hoe zou u de huidige discussie binnen uw waterschap beschrijven over de rol van waterschappen bij het bevorderen van het circulair gebruik van baggerspecie? o Wat vindt u hiervan?
Circulair Bagger Consortium (CBC)	Wat is volgens u de meerwaarde van de deelname van uw waterschap aan het CBC?

	Bent u wel eens aanwezig geweest bij de sessies die het CBC elk kwartaal organiseert? Waarom wel/niet? o Zo ja, hoe ervaart u deze sessies?
	Deelnemers van het CBC hebben samen met een visie gecreëerd voor het circulair gebruik van baggerspecie: *In 2030 wordt* ***alle baggerspecie****, van vrij-toepasbaar tot niet-toepasbaar, 50% circulair toegepast. Dat betekent dat de bagger* ***hoogwaardig****,* ***CO2 neutraal*** *en zo* ***lokaal*** *mogelijk wordt gebruikt. Dit doen we door samen te werken in de keten en waar nodig de baggerspecie voor te bewerken.* o Wat vindt u van deze visie? o Waarom?
	Het thema van de eerste sessie van het CBC betrof bottlenecks/obstakels voor het realiseren van een van een circulaire baggerketen. o Wat zijn volgens u de belangrijkste bottlenecks? o Kunt u hier voorbeelden van geven?
	In de tweede CBC-sessie lag de focus op circulariteit meenemen in aanbestedingsprocessen. o Hoe ziet u deze verandering voor de aanbesteding van baggerprojecten voor u?
	Is het belangrijk om aanbestedingsprocessen te veranderen om circulair gebruik van baggerspecie te bevorderen? o Waarom wel/niet?
	Er is discussie ontstaan over wat er precies aanbesteed moet worden met betrekking tot een circulaire baggerketen: alleen het baggeren en eventueel voorbewerken – of het aanbesteden van de hele keten. [*LAAT FIGUUR 10 ZIEN*] o Hoe ziet u dit?
	Wat ziet u als de grootste obstakels om aanbestedingsprocessen aan te passen? o Kunt u hier voorbeelden van geven? o Hoe zouden deze opgelost kunnen worden?
Aanbevelingen	Welke aanbevelingen of inzichten heeft u voor andere waterschappen die een vergelijkbare weg willen inslaan naar het circulaire gebruik van baggerspecie?

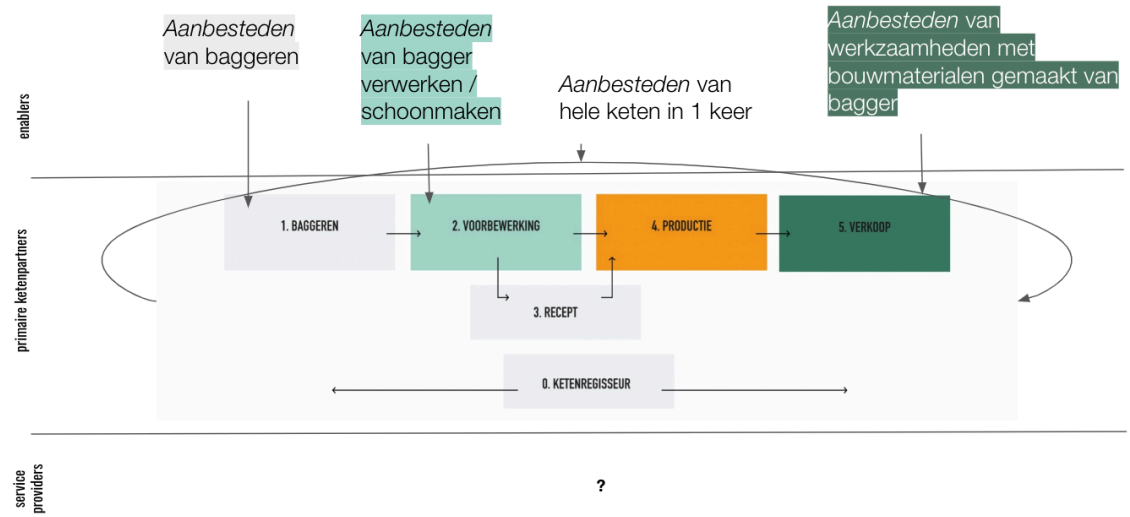

Figure 10. Aanbesteden circulaire baggerketen

Afronding

- Dat was mijn laatste vraag.
- Ben ik nog dingen vergeten te vragen of zijn er dingen die u graag kwijt wil?
- Dan stop ik nu de opname en bedank ik u heel hartelijk voor uw tijd!

[AUDIO-OPNAME STOPPEN]

- Ik ga aan de slag met transcriberen en analyseren
- Op de hoogte gebracht worden van resultaten onderzoek?
    - Zo ja, dan zal ik u mailen.
- Kent u misschien nog iemand anders die ik zou kunnen spreken?
- Nog vragen?
- Afscheid nemen.

APPENDIX C – INFORMED CONSENT FORM

Before conducting the interviews, each interviewee was asked to sign the informed consent form below.

Onderzoeks-Toestemmingsformulier (Informed Consent Form)

U wordt uitgenodigd om deel te nemen aan een onderzoek met de titel " *Water Boards Navigating the Transition towards Circular Use of Dredged Sediment" (Waterschappen navigeren de overgang naar circulair gebruik van baggerspecie).* Dit onderzoek wordt uitgevoerd door Joséphine Loudon van de TU Delft.

Doel van het Onderzoek:
Het doel van dit onderzoek is om inzicht te krijgen in de rol van waterschappen bij het navigeren door en vormgeven van de overgang naar hergebruik van baggerspecie voor circulariteit. Het interview zal ongeveer 45 minuten duren. De verzamelde gegevens worden gebruikt voor de analyse van thema's in de discussie onder medewerkers van waterschappen. Ik zal u open vragen stellen.

Gegevensverzameling:
Tijdens dit onderzoek zullen de volgende gegevens van u worden verzameld:
- Persoonlijke gegevens, waaronder uw naam, e-mailadres, werkgever en beroep.
- Opnames en transcripties van het interview.

Gegevensopslag:
De verzamelde gegevens worden opgeslagen op de volgende locaties:
- Beveiligde TU Delft-drive

Toegang tot Gegevens:
De volgende personen of groepen hebben toegang tot de verzamelde gegevens:
- De onderzoeker (Joséphine Loudon)
- TU Delft begeleider (Udo Pesch)

Openbaarmaking van Gegevens:
Alleen de werkgever zal in de publicatie worden genoemd. Verdere persoonlijke gegevens zullen anoniem blijven.

Bewaring van Gegevens:
Persoonlijke gegevens worden bewaard gedurende een periode van 2 jaar na afloop van het project. Na deze periode worden ze verwijderd.

Vertrouwelijkheid:
Uw identiteit als geïnterviewde in dit onderzoek blijft vertrouwelijk. De onderzoeker zal er alles aan doen om uw vertrouwelijkheid te waarborgen, inclusief de volgende maatregelen:
- Toewijzen van codenamen/nummers aan deelnemers die worden gebruikt op alle onderzoeksnotities en documenten.
- Het bewaren van notities, interviewtranscripties en alle andere identificerende informatie van deelnemers in een vergrendeld bestand in de cloud van de universiteit.

De gegevens van de deelnemer worden vertrouwelijk bewaard, behalve in gevallen waarin de onderzoeker wettelijk verplicht is om specifieke incidenten te melden, zoals gevallen van misbruik en suïciderisico.

Vrijwillige Deelname:
Uw deelname aan dit onderzoek is vrijwillig. Het is aan u om te beslissen of u al dan niet wilt deelnemen aan dit onderzoek. Als u besluit deel te nemen aan dit onderzoek, wordt u gevraagd dit toestemmingsformulier te ondertekenen. Zelfs nadat u het toestemmingsformulier heeft ondertekend, bent u nog steeds vrij om op elk moment en zonder opgaaf van reden terug te trekken. Het terugtrekken uit dit onderzoek zal geen invloed hebben op de relatie die u heeft, indien van toepassing, met de onderzoeker. Als u zich terugtrekt uit het onderzoek voordat de gegevensverzameling is voltooid, worden uw gegevens aan u teruggegeven of vernietigd.

Contactgegevens:
Als u op enig moment vragen heeft over dit onderzoek, of als u nadelige effecten ervaart als gevolg van deelname aan dit onderzoek, kunt u contact opnemen met de onderzoeker, [Joséphine Loudon], via [+31627876439], of Udo Pesch (TU Delft begeleider) via [u.pesch@tudelft.nl]. Als u vragen heeft over uw rechten als deelnemer aan het onderzoek, of als er problemen ontstaan waarover u niet met de hoofdonderzoeker wilt praten, neem dan contact op met de TU Delft via [info@tudelft.nl].

Door hieronder te tekenen, verklaart u dat u de informatie in dit toestemmingsformulier heeft gelezen en begrepen en ermee instemt deel te nemen aan het onderzoek onder de hierin beschreven voorwaarden.

Naam deelnemer: _____

Handtekening deelnemer: _____
Datum: _____

APPENDIX D – MORE INFORMATION ON THE DREDGING ECOSYSTEM

This appendix elaborates on chapter 6 of this research.

DETAILED EXPLANATION OF THE DREDGING CHAIN

The dredging process is a complex and multi-step operation that involves various stakeholders, including the Water Board, contractors, depots, subcontractors, and other relevant parties. Figure 1 demonstrates the steps, timeline and actors in the current dredging chain. Below each step is explained more elaborately. The numbers correspond to the numbers in Figure 5.

1. Sampling of dredged material: The dredging process commences with a crucial step involving the active collaboration of the Water Board, Depot, Contractor, and Sampler. The Water Board, acting as the central orchestrator, sets in motion the strategy for collecting samples of the material that necessitates dredging. In conjunction with the Depot, logistical support is provided to ensure that the sampling operation is carried out seamlessly. The Contractor, under the guidance of the Water Board, is responsible for physically collecting samples from the waterway. The Sampler, an integral part of the process, carries out the hands-on task of collecting samples that accurately represent the material to be dredged. This synchronized effort guarantees that the collected samples are representative of the materials requiring removal, laying the foundation for informed decision-making throughout the dredging process.

2. Analyzing the dredged material: The collected samples find their purpose in the analysis orchestrated by the Water Board. Utilizing laboratory facilities and the expertise of skilled analysts, the Water Board delves into a comprehensive assessment of the material's composition, contaminants, and physical attributes. The role of the Sampler extends to assisting in this analysis, ensuring that the collected samples are accurately processed. This detailed analysis culminates in the determination of the dredge class, a pivotal classification that sheds light on the contamination level and guides the selection of appropriate disposal methods. Moreover, the analysis contributes to the estimation of costs, providing valuable insights for budgeting and project planning.

3. Tender for the disposal site: Collaborative efforts between the Water Board and Depots mark a significant phase in the dredging process. This joint effort involves evaluating potential disposal sites for the dredged material. The Water Board, leveraging its expertise in environmental and regulatory considerations, collaborates with the Depots to pinpoint sites that align with logistical requirements and adhere to regulations. Depots, equipped with knowledge in storage and regulations, contribute potential site options for consideration. This collaboration ensures that the chosen disposal site complies with environmental standards and supports responsible management of the dredged material.

4. Creating specifications & issuing a tender: The precision of the dredging process hinges on the collaborative expertise of the Water Board, Supervisor, Water Board procurement

department, and Contractors. Senior employees within the Water Board, drawing upon their technical and environmental expertise, draft specifications that outline the details of the dredging assignment. Their work is informed by the inputs of Supervisors, who contribute technical insights to the specifications. The Water Board procurement department takes charge of managing the tendering process, ensuring transparency and fairness. Meanwhile, Contractors engage actively by responding to the tender with comprehensive proposals that mirror their capability to execute the project in accordance with the specifications. This intricate web of collaboration guarantees that the project's technical and environmental aspects are adequately addressed.

5. Selecting a contractor for dredging: The specialized committee within the Water Board takes on the pivotal role of evaluating Contractor proposals. This committee, comprising experts from diverse domains, engages in an assessment process. They critically evaluate the submitted proposals, considering not only the technical competence of the Contractors but also the commitment to environmental considerations. The Contractor, as a primary actor, responds with a proposal that showcases their technical proficiency and environmental responsibility. This collaborative evaluation ensures that the selected Contractor aligns with the project's goals of minimizing ecological impact and efficiently executing the dredging operation.

6. Alcatel period: This phase is characterized by a collaborative evaluation period between the Water Board procurement department, Water Board maintenance department, and the Contractor. The Water Board's procurement department facilitates open communication between the Water Board and the Contractor to ascertain the feasibility of the project. The Water Board maintenance department, drawing on their technical knowledge, assesses the Contractor's capacity to meet the technical requirements. Meanwhile, the Contractor takes on the responsibility of reviewing their resources, equipment, and workforce to confirm their ability to fulfill the dredging assignment. This collaborative effort culminates in ensuring that the project's operational aspects are thoroughly aligned and achievable.

7. Permits & accessibility check: Regulatory compliance and smooth operational execution take precedence in this phase, demanding the collaborative engagement of the Water Board and the Contractor. The Water Board, leveraging their relationships and expertise, engages with provincial and municipal authorities to secure the necessary permits for the dredging project. Simultaneously, the Contractor, with their operational insights, collaborates with authorities to address permit-related requirements. This collaboration guarantees that the project adheres to regulatory mandates and operates with the necessary permissions. The period in which permits and accessibility are checked happens every year between the first of September and the first of April.

8. Dredging: As the heart of the dredging process, this step witnesses the Contractor in full action, supported by subcontractors and overseen by the Water Board. The Contractor takes the lead, employing their expertise and utilizing the specified equipment and methods to execute the physical dredging operation. Subcontractors join in to assist the Contractor in this operation. Meanwhile, the Water Board plays a significant role in providing oversight,

ensuring that the dredging process adheres to established specifications and regulatory guidelines. This collaborative approach guarantees that the dredging operation is efficient, controlled, and aligned with the project's objectives. Dredging is executed every year between the fifteenth of July and the first of November. This has to do with the breeding season, a significant phase in the life cycle of birds. Dredging is not allowed whilst birds are in the process of laying their eggs to ensure their well-being and protection ("Waterbodembeleid en baggeren," n.d.).

9. Dredge at adjacent plots: As a component of the dredging process, if the chemical qualities of the dredged material allow it, local farmers are obligated to allocate space for storing a portion of the dredged material. This allocation is managed in accordance with environmental guidelines to ensure the safe and responsible storage of the material (van Rijswick, 2014). This step not only demonstrates the integrated nature of the process but also underscores the importance of engaging with the local community in dredging processes.

10. Transporting wet dredged material: Transportation logistics are at the forefront of this phase, requiring the coordinated efforts of the Contractor and subcontractors. The Contractor spearheads the orchestration of transportation logistics, ensuring the safe and efficient transport of the wet dredged material from the waterway to the designated depot. Subcontractors actively participate in the operation, operating trucks and equipment for material transport. The collaboration of these actors ensures that the wet material is transported responsibly and without incident.

11. Disposal in depot for contaminated dredged material: The proper disposal of contaminated dredged material requires close cooperation among the Depot, contractor, and subcontractors. The depot, owing to its expertise, takes charge of receiving the contaminated material and overseeing its careful placement into specialized containment units that adhere strictly to regulatory guidelines. Simultaneously, the contractor and subcontractors work in tandem with the depot to ensure a well-organized process for depositing the contaminated material. This collaborative effort is vital to ensure responsible storage of the contaminated material, mitigating environmental risks, and maintaining full compliance with all required standards.

12. Depositing dredged material in a transit depot: The expertise of the Depot, in collaboration with the Contractor and subcontractors, plays a pivotal role in this step. The Depot manages reception of the wet material, overseeing the process of depositing the material into drainage containers. This ensures that the material is properly contained and adheres to regulatory guidelines. Meanwhile, the Contractor and subcontractors work in tandem, coordinating with the depot to ensure organized and efficient material deposition. This collaborative effort ensures that the material is stored responsibly.

13. Drying the dredged material: The expertise of the Depot comes into play again in this phase, wherein the sun-drying process is undertaken within the drainage containers. The Depot oversees this process, monitoring the gradual reduction of moisture content within the material. This drying process is essential to enhance the material's quality for further

applications, setting the stage for its transformation into a resource with improved characteristics.

14. Transporting dry dredged material: Logistics once again take center stage, demanding the orchestrated collaboration of the Contractor and subcontractors. The Contractor takes on the responsibility of arranging transport logistics for the dried material, ensuring that it is efficiently moved to its designated application site. Subcontractors actively execute this transportation operation, guaranteeing the safe and secure movement of the dry material. This collaboration ensures that the improved material quality is preserved during transportation.

15. Application of dredged material: The final phase of the dredging process sees the Contractor, specialized in construction projects, deploying their expertise to maximize the utility of the dried material. For example, the Contractor applies the material for land reclamation

REGULATIONS

In the Netherlands, water boards operate under a complex yet flexible regulatory framework with regards to dredging activities. The main framework concerning dredging is the *Besluit Bodemkwaliteit* (Soil Quality Decree). This regulation serves as a cornerstone for ensuring that dredging activities are conducted in an environmentally responsible manner. Below the most important points in the decree are mentioned.

Reporting and Transparency

One of the first steps in any dredging operation is the mandatory reporting requirement. Water boards are obligated to inform designated reporting centers about their plans to apply dredged material either on land or in surface water bodies. This reporting mechanism ensures a high level of transparency and allows for the monitoring of activities to ensure they meet environmental standards. It also provides an opportunity for public scrutiny, as these reports are generally accessible to the public, thereby fostering an ethos of accountability.

Ensuring Environmental Health

Before any dredging activity can commence, water boards are required to produce an Environmental Health Statement. This document serves as a testament to the quality of the materials that will be involved in the dredging process. It is a safeguard designed to ensure that the dredging activities do not have an adverse impact on the quality of the soil or water. These statements are not just bureaucratic formalities; they must be retained for a minimum of five years and are subject to auditing and monitoring, ensuring long-term accountability.

Quality Systems and Certifications

If a dredging project involves the handling of polluted soil or dredged sediment, the water board must adhere to a certified quality system. This system is designed to meet specific requirements for the safe and responsible handling of polluted materials. Compliance is often demonstrated through a certification process, which is a prerequisite for many dredging projects. This ensures that even in situations involving contaminated materials, environmental risks are minimized.

Provincial Permits and Environmental Protection

In cases where non-dangerous dredged material is to be deposited on land, water boards must obtain a permit from provincial authorities. These permits are not granted arbitrarily; they come with a set of conditions outlining the environmental protection measures that must be adhered to. This adds an additional layer of oversight and ensures that local environmental factors are taken into consideration.

Chemical Quality Assessments

Before the actual process of dredging begins, a thorough chemical quality study of the dredge spoil must be conducted. This is a critical step to ensure that the material meets the stringent environmental standards set forth by the *Besluit Bodemkwaliteit*. Only after compliance has been verified can the dredging operation proceed, ensuring that environmental integrity is maintained.

The *Besluit Bodemkwaliteit* introduces the concept of *Lokale maximale waarden* (Local Maximum Values), which empowers local water authorities to set their own maximum permissible levels for pollutants such as heavy metals or organic compounds. This localized approach allows for regulations that are tailored to the unique environmental conditions of each area. For example, a water board overseeing a region with agricultural runoff may set different permissible levels for nitrates compared to a board managing an industrial area.

Alignment with EU Regulations

The Besluit Bodemkwaliteit is not an isolated regulation; it aligns with broader European Union directives on environmental protection. This ensures that the Netherlands' stringent environmental standards are in harmony with those of other EU Member States, fostering a unified approach to environmental conservation across borders.

Legal Consequences of Non-Compliance

The Besluit Bodemkwaliteit is backed by a robust legal framework. Failure to comply with its guidelines can result in severe penalties, including hefty fines, legal action, and even the revocation of permits. This serves as a strong deterrent, ensuring that water boards operate within the boundaries of the law and adhere to best practices in environmental conservation.