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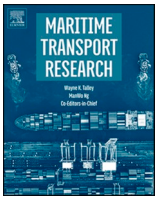

Spatial planning of the circular economy in uncertain times Focusing on the changing relation between port, city, and hinterland

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ABSTRACT

The circular economy (CE) brings many opportunities, but also many challenges for ports, cities, and their hinterland. The goal of this paper is twofold. First, we embrace the inherent uncertainty of the spatial impact of the CE on ports and cities. We employ scenario methodology to guide us in steering this uncertainty by developing four scenarios. To explore the complexity of these four scenarios, we focus on the Dutch province of South-Holland. This region hosts the port of Rotterdam, the largest port in Europe, and its direct hinterland consists of a dense urbanised region. As such, the four scenarios cannot only shed a light on the future of the port, but also how its relations with its direct urbanized hinterland can potentially change. In two scenarios deglobalisation occurs. The consequences are, on the one hand, that the port's focus changes more to its direct hinterland instead of a global oriented focus. On the other hand, the existing water bound industrial areas in, or nearby cities increase in importance, in contrast to the contemporary pressure to redevelop these into waterfront residential and commercial areas. In other words, port and city/region grow towards each other. The second goal of the paper is to dive into the specific consequences of these scenarios for day-to-day planning practices. By combining micro-economic and AIS shipping data, we discovered the most important terminals and industrial areas for the transition towards a CE in port, city, and hinterland.

1. Introduction

This article aims to bring two groups of literature together: the question of territorialisation or the role of space in a circular economy (CE) (Tapia et al., 2021; Torre & Dermine-Brullot, 2021; Van den Berghe & Verhagen, 2021; Williams, 2021; Wuyts & Marin, 2022), and the role of ports in the CE transition (Faut et al., 2023; Haezendonck & Van den Berghe, 2020; Notteboom et al., 2024). Both have recently gained attention. First, the former group of literature developed out of the critique that the CE is too often regarded as

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footloose and perceives space as an equal or even more important resource in a CE as materials (van Bueren et al., 2022). While there is no clear definition of what a CE entails(Kirchherr et al., 2017), increasingly there is a general understanding of its core principles and enablers; cf. to reduce the use of materials and energy, achieved through business models, policies, and consumers (Jabbour et al., 2019; Kirchherr et al., 2023). Critiques on the CE concept are broad, for example, stressing its impossibility beyond aspiration (Lehmann et al., 2022), or its over emphasis on economic sustainability as leading principle (Blum et al., 2020; Corvellec et al., 2021). What is overall missing is, though, why and how a systemic change in production and consumption should be pursued (Kirchherr & van Santen, 2019). Therefore, in this article, we underline, in this systemic view of a CE, the need to understand territorialisation (Blomsma & Brennan, 2017; Chembessi et al., 2024; Tapia et al., 2021).

Second, the latter group of literature developed from the increasing insight that the role of ports is or should profoundly change, to decrease their ecological impact, to increase (again) the number of qualitative and diverse jobs, or to remain economic competitive, for example, by creating circular loops of energy and materials (Haezendonck & Van den Berghe, 2020; Moeremans & Dooms, 2024). More recently, studies have reflected on what different possible roles for ports. For example, the Dutch Board of Government Advisors (CRa) recently argued that there are four possible roles, namely a continuation of (i) the main port model focussing on quantitative growth, (ii) the recycle delta that builds upon the existing economic networks, but favours ecological principles instead of economic, (iii) the manufacturing industry, whereby specifically land-use choices are made in favour of production of goods, instead of for example logistical activities, and (iv) circularity, wherein the leading principle is what favours the regional economy (CRa, 2024). However, these studies remain, to some extent, vague, and arguably they often lack a link with space or its environment, and lack a specific strategy of how land use choices need to be made.

The mentioned deficiencies of the two fields are not such a surprise. It is, namely, difficult to make general insights specific because one of the certainties of the CE transition is it is uncertain (PBL, 2023b). This uncertainty is inherent in the current so-called 'polycrisis' (Tooze, 2022), wherein different social, ecological, economic, and political crises are interacting. From an economic perspective, after decades of (hyper)globalisation, with an enormous increase of the relative added value of trade activities on a global scale, since the crises of 2008 we arrived first in a 'slowbalisation', and increasingly in a deglobalisation (Van Bergeijk, 2022). While it is debatable if this deglobalisation is temporary and maybe will bounce back as during Brexit or the Covid pandemic, the political rhetoric of deglobalsation cannot be ignored anymore and will have or is having definitely an impact on the global economy (COM, 2024; Latour, 2022; Livesey, 2018). Though, again, much or even everything is uncertain (Yeung, 2024).

For Western economies and societies, this uncertainty is increasingly becoming a huge challenge. During globalisation, especially the Western economies transferred into service-based economies. This had a significant effect on both cities and ports. First, several cities via services like consultancy, finance, insurance, education, etc. became part of so-called ranked world cities, controlling and dictating global economies (Friedmann, 1986; Sassen, 1991). Second, simultaneously, foremost industrial activities became externalised to other parts of the world. From a perspective of urban planning, some cities successfully became 'post-industrial' cities (Hall, 1997), while others became 'places left behind' (Martin et al., 2021).Also ports transferred from industrial to service oriented systems. As described by Slack (1993), ports became increasingly pawns in the global game of commerce. In a nutshell, two related phenomena came together. First, because of globalisation, former national boundaries and deligned economies became part of global markets, wherein optimisation occurred across borders. In relation to this, second, the container, as technology invented a few decades before, became highly instrumental to guide this emerging global market by allowing intermodal transport, decreased (un)loading times, and easier upscaling (Levinson, 2010).

Summarized, for both ports and cities, it became less and less a choice to facilitate the service economy by for example infrastructure investments. For cities, these are central business districts, nice and high-end living environments, or cultural programs. For ports, these are terminals, docks, railways etc. While it remained uncertain if investments in infrastructure would pay off, it was certain that if these investments did not occur, for sure no important (global oriented) activities, both in port and city, would arrive (Slack, 1993).

Increasingly, the benefits were for a smaller group of actors, and often outside the port, and the burdens increasingly for the local surrounding environment (Hall & Jacobs, 2012). In no ranked order, the latter relate to logistical burdens (e.g. traffic jams), socio-economic burdens (e.g. a decrease of the quality and quantity of jobs), and ecological burdens (e.g. air pollution). More recently geopolitical burdens, especially for ports, increase, realising the lack of domestic energy and material resources. Many private and policy recommendations have been or are proposed, among those the CE. For example, Corvellec et al. (2021) explained that the CE can be used to react on the increasing scarcity of materials by keeping the loop of these materials close to themselves. But as explained above, combining the fields wherein the consequences of the CE for ports and cities have been developed, could help both. This leads to our research question: What are the consequences of the CE transition for the spatial planning of port and city?

To be able to answer this research question, we focus on the Dutch province of South-Holland. South-Holland hosts not only the port of Rotterdam but is also a dense urbanised region with cities like Rotterdam, Delft, The Hague, and Leiden. All these cities are, in different forms, well accessible by water bound transport, between each other and from and to the port of Rotterdam, due to the dense network of canals. Regarding the potential, though uncertain spatial impact of the CE transition on port, city, and region (PBL, 2023a), and as such also the relation between port and hinterland, the province of South-Holland thus provides a promising perspective, not the least because relevant actors in the province have thought of wat a CE could imply for many years (e.g. Provincie Zuid-Holland, 2023; TNO, 2022). Next to the port of Rotterdam, the province hosts 617 industrial areas, and following the dense urbanised region, many of these are in or nearby cities. Fuelled by a housing shortage, this for a large extent explains why many industrial areas are currently subject to redevelopment to residential and commercial land use (Provincie Zuid-Holland, 2020). Especially the water bound industrial areas are popular. Nonetheless, recent research (STEC, 2023) has argued that municipalities don't include enough the need for water bound industrial areas to facilitate the CE transition of their cities and region, hence shedding a light on the potential effects of

the CE on spatial planning (TNO, 2022). Summarized, the CE transition and its inherent uncertainty makes it challenging to on a longer term spatially plan port, city, and region.

The article is structured as follows. In the next section we explain first why taking a spatial perspective when operationalising the CE is essential, and second how uncertainty in spatial planning can be incorporated through explorative scenario planning (XSP). Next, in our methodological section, we propose to combine qualitative and quantitative methodologies, to achieve the 'sweet spot' between long term alternative futures and practical and clear measures. After our results, we end with a discussion and conclusion.

2. Background

2.1. Territorialisation of CE

While there are many CE definitions (Kirchherr et al., 2017), in one way or another they emphasize one or more of the following five principles: (i) a circular flow of materials and energy, (ii) a slowing down of that circle, (iii) a reduction in the amount of materials and energy, (iv) a substitution of non-sustainable materials with sustainable ones that allow for regeneration, and (v) a geographical concentration (Dabrowski et al., 2024). The latter principle is, however, not straightforward. The attention for the role of place is often missed or is not explicitly mentioned, like in the Ellen MacArthur Foundation definition (EMF et al., 2015), or has only more recently been identified as a crucial element (Baumgartner et al., 2024; Tapia et al., 2021; Torre & Dermine-Brullot, 2021; Tsui, Venverloo, et al., 2024; Tsui, Wuyts, et al., 2024; Van den Berghe & Vos, 2019). The role of space is not always regarded as positive. Calisto Friant et al. (2020) caution that an overemphasis on localism can result in 'fortress CEs', where control over material reuse becomes a strategic tool (Van den Berghe & Dabrowski, 2024). This interpretation, however, diverges from the broader principle of localism. As explained by North (2010), localism strives to organise consumption-production systems as local as possible, leaving open the option that in some cases a larger scale can also be beneficial (Kinnunen et al., 2020).

The main point is for a CE is to become a reality, it must take place in specific locations involving local actors, infrastructures, and industries (Niang et al., 2024; Van den Berghe et al., 2018; Yeung, 2005, 2024). In turn, this leads to a reality check of who and where responsibility lies, leading, in the end, to the how (Hobson, 2019; Kirchherr et al., 2023). This shift suggests and increasing politicisation of CE (Kębłowski et al., 2020; Nygaard, 2022), with a growing emphasis on the societal aspects of the economy, rather than focusing purely on ecological dimensions (Köhler et al., 2019; Wuyts & Marin, 2022). Therefore, by putting an emphasis on space or the territorialisation of the CE, critiques on the CE concept, like greenwashing, being naïve, or impossible, could be countered. A spatial perspective often reveals difficult choices, particularly regarding land uses that are hard to integrate, such as waste processing. These challenges make it harder to externalise problems from specific cities or regions (Dryzek, 1987; Emel & Peet, 2001 [1989]; Krähmer, 2021). In summary, the territorialisation of the CE highlights the complex spatial decisions that must be made as localism and resource management take on increasing importance. This complexity becomes even more pronounced when considering the inherent uncertainty in how these spatial challenges will evolve, as we discuss in the next section on scenario planning.

2.2. Explorative scenario planning (XSP)

Dealing with uncertainty and change is challenging. A well-known methodology within the field of futurology or future studies to deal with (un)foreseen eventualities is the use of scenarios (Börjeson et al., 2006). Scenarios consider the course of current events that could lead to the future situation. They help to move forward from the actual situation to the future situation by providing a roadmap of potential paths. In modern times, scenario methodology found its first systematic use at the American RAND corporation (cf. Research AND Development) think tank during the 1950s, where it was used for, foremost, military planning purposes (Amer et al., 2013). Shell popularised and intensively used this method of future studies during the 1960s, initiated by their 'Year 2000′ study in 1967 (Bradfield et al., 2005), and this led to Shell being able to cope with the oil shocks during that decade (Amer et al., 2013; Jefferson, 2012). After this turbulent decade, the use of scenarios increased significantly among companies, and they are used for different purposes and by many different users, from small to large companies, and from private to public organisations.

Numerous scenario methods have been developed, so many that it is often seen as a methodological chaos (Amer et al., 2013; Bradfield et al., 2005). They can be simplistic or complex, qualitative or quantitative. Börjeson et al. (2006) propose to use three categories: forecasting, backcasting, and explorative scenario planning (XSP). First, forecasting, or predictive scenarios try to predict the future outcomes based on occurrence probability and likelihood. Often, forecasting is used to test outcomes of policies to support decision-making and planning processes. In contrast to developing visions, forecasting deals with projection (Wachs, 2001). While forecasting is quite popular as it fits well to test the business-as-usual scenarios, for example within transport planning, it is also critiqued. On the one hand, there is the so-called 'fallacy of extrapolation' (Riegelman, 1979), or overconfident extrapolation, that is an inductive reasoning error in which someone draws a broad conclusion based on limited or insufficient evidence. As such, forecasting neglects underlying functional systems and complexities that may change over time (Flyvbjerg et al., 2005). Second, there is backcasting or normative and visioning scenarios. Backcasting tries to generate a desirable future – often a few decades into the future -, and subsequently looks backwards to the present in order to plan a strategy to achieve this future (Vergragt & Quist, 2011). A drawback of backcasting is that it selects one normative vision (Bibri & Krogstie, 2019). Therefore, thirdly, Unlike forecasting, which focuses on predicting probable outcomes, or backcasting, which envisions a single desired future, XSP broadens the scope of possibilities. It allows for the exploration of multiple, diverse futures by explicitly focusing on external uncertainties, making it particularly valuable for navigating the unpredictability inherent in the circular economy's spatial planning(Chermack et al., 2001). While XSP became extensively used among corporates, spatial planning was slow to adopt it (Chakraborty et al., 2011). Businesses tend to adopt XSP more

readily because they often focus on a single strategy or goal. In contrast, spatial planning, which must balance multiple and often conflicting public interests, has been slower to adopt XSP due to its need to account for a broader range of potential outcomes (Avin & Goodspeed, 2020). This paper, therefore, seeks to harness the potential of XSP by combining qualitative scenario narratives with quantitative data analysis. This combination allows for a more comprehensive understanding of the potential spatial outcomes for the circular economy in South-Holland.

3. Methodology

The first step is the development of qualitative scenarios. We follow the intuitive logics methodology and can be regarded as the most popular today (Bradfield et al., 2005). The assumption is that decisions are influenced by a complex set of relationships (Abou Jaoude et al., 2022). Intuitive logics methodology varies, with some versions including five to fifteen steps (Amer et al., 2013). In this article, we adopt the widely recognised five-step approach, as this framework is commonly used in scenario planning (Foster, 1993; Postma & Liebl, 2005; van Eijkelenburg & van Harn, 2021). Before we can explain these five steps, another choice that needs to be made, is how many scenarios will be developed. As argued by Pillkahn (2008) the ideal number is four scenarios, or a 2 × 2 scenario matrix method (Bauwens et al., 2020; van Asselt & van't Klooster, 2012).

The first step in the five-step methodology is the identification of relevant driving forces. To ensure a comprehensive analysis, these forces are categorised into five broad areas: social, technological, economic, ecological/environmental, and political (abbreviated as STEEP).. Via desktop analysis, we derived 56 relevant driving forces, deducted from examining 150 documents, among these were policy documents of the province of South-Holland, industrial strategic visions of economic sectors and companies, scientific articles, books, and media. Following many driving forces are related, in the second step a clustering occurs across the STEEP categories. We identified 15 trend clusters that are relevant for the province of South-Holland. Arguably, the third step is the most crucial one, because in this step the different trends are mapped along their impact and uncertainty. In addition to considering relevant similar scenario exercises for the Netherlands (e.g. CRa, 2024; PBL, 2023b), our exercise for the province of South-Holland was conducted during an expert meeting in The Hague, the Netherlands, on the 23rd of January 2023, involving academics from the Erasmus University Rotterdam and the Delft University of Technology, and policy makers from the province of South-Holland. The two key trends identified during the expert session as having the greatest impact and uncertainty were deglobalisation and labour supply issues(cf. Burger et al., 2019). These trends are particularly relevant to the socioeconomic profile of South-Holland, given the region's reliance on global trade and its evolving labour market needs. First, following the port of Rotterdam, but also following its global oriented horticulture and urban economies with their universities, multinationals, and international governmental institutions among others, the province of South-Holland is strongly linked to the global. A (minor) change, both positively and negatively, can have significant consequences for the economic development of the province. For decades, this was not really a concern and the planning based on this followed 'easily'. Though, as explained in this paper, this changed recently. Second, following the energy transition (in particular the need for more and stronger electric grids), climate change (e.g. higher dikes, locks), or infrastructure (e.g. circular redevelopment of bridges), the current and future need of labour is needed, though it is highly uncertain – not the least following (de)globalisation – if there will be a sufficient or excessive amount of labour. In step four, the two trends identified—deglobalisation and labour supply—serve as the axes for the 2 × 2 scenario matrix, shaping the development of four distinct future scenarios, step five. This approach allows us to explore multiple outcomes under different combinations of these uncertainties.

Our addition is that we complemented these qualitative scenarios with quantitative mapping of the current situation, namely the role of water bound transport for the CE in the province of South-Holland. First, we used the IBIS-dataset (IPO, 2021) to identify all 617 industrial areas in the province of South-Holland (Provincie Zuid-Holland, 2022). Second, for all these industrial areas, we looked at the CE activities, presented in the percentage of the total area. For this, we used the LISA dataset 2019, a micro-economic dataset describing the location and business activity of all companies in the province of South Holland (Kadaster, 2022; LISA Founding, 2019). For the CE activities, we used the CE SBI selections by van Oort et al. (2018) and PBL (2019). The used selection is useful, though not perfect. Nevertheless, we are convinced this list is for the largest part instrumental as the selection was based on the R-ladder. First, SBI codes mentioning 'repair' for example were labeled as CE, but next to that a comprehensive survey was used to verify more the list of CE activities (see for more information Kishna et al., 2019), in particular if not specifical a R-strategy was mentioned in their SBI label. Finally, the average amount of circular area on business terrains in South Holland is 20%.

Next, we did a topological mapping of the water bound transport t0, from, and within the industrial areas in South-Holland. To track real time ship movements, we used Automatic Identification System (AIS) data. AIS is a tracking system used in maritime navigation to exchange real-time information between ships and shore stations. The data includes information about position, speed, size, and type of vessel. This study used a database of ship movements created by a previous research project at TU Delft (Van den Berghe, Peris, et al., 2022), during the summer of 2019 (June 16 to September 16). In total 325,865 ship movements were registered towards, from, or within the province of South-Holland. An algorithm was run to find out where vessels stop. A "stop" is defined by when a ship is stationary for more than 2 hours and less than 30 days.

Shipping movements were then mapped to understand the degree of connectivity (via water transport) between industrial areas within the province. For each industrial area, it was assumed that all ship stops within a 500 m buffer zone indicated that the ship stopped at the area. This allows us to determine which industrial areas were frequently visited by ships, and therefore fully utilised the water transportation network. When a ship travels from one industrial area to another, it was assumed that these two areas were connected. Trip frequency and total volume were used to estimate the degree of connection between two industrial areas. Trip frequency was calculated by counting the total number of trips made between two areas. The volume transported between two areas was estimated using the ship size for each trip (see for detailed algorithm: Van den Berghe, Peris, et al. (2022)). The total volume exchanged

between two areas was then calculated by multiplying the number of trips by the volume of each trip. The same methods were used to calculate the degree of connectivity between the province and other countries.

Finally, an analysis was conducted to understand the network of industrial areas in the province, connected via shipping trips. In this analysis, the industrial areas are "nodes", and the weighted by load shipping trips are the connecting "edges" within the network. By using the force-directed layout algorithm Fruchterman-Reingold, we identified the centrality of the different industrial areas in the network of ship movements. Thus, we were able to quantify and identify the most important or influential industrial areas within the network based on their connectivity and structural importance. Network centrality analysis is important, because an industrial area that is frequently visited by ships is not necessarily an important node within the network if these ships carry not much cargo, and vice versa, an area that receives a lot of cargo, but only via a few ships is not the most important node within the network. Lastly, in this paper we topographically presented this topological network of industrial areas showing the degree of centrality of circular business areas, visualized by the size of circles

4. Results

4.1. Qualitative scenario planning of the future alternatives

The scenario planning used yielded four different scenarios. Conceptually, the centre forms the business-as-usual, while the four scenarios follow the two axes of globalisation versus de-globalisation and labours surplus or labour shortage (Fig. 1).

In scenario Clipper, globalisation continues to progress, resulting in a labour surplus and low geopolitical tensions. Global trade flourishes, particularly benefiting the service sectors such as logistics, care, research, and consultancy. However, this economic growth increases pressure on housing and land use, exacerbating existing spatial conflicts between ports and urban areas Subsequently, on top of the already contemporary tens land use conflict between port and city (e.g. Van den Berghe, Louw, et al., 2022). Polarisation increases further between different economic sectors (e.g. agriculture versus urban services) and can be tempered by an increased social housing policy and strict spatial zoning. (in case of polarisation, see in particular RLI, 2020). The Netherlands further de-industrializes,

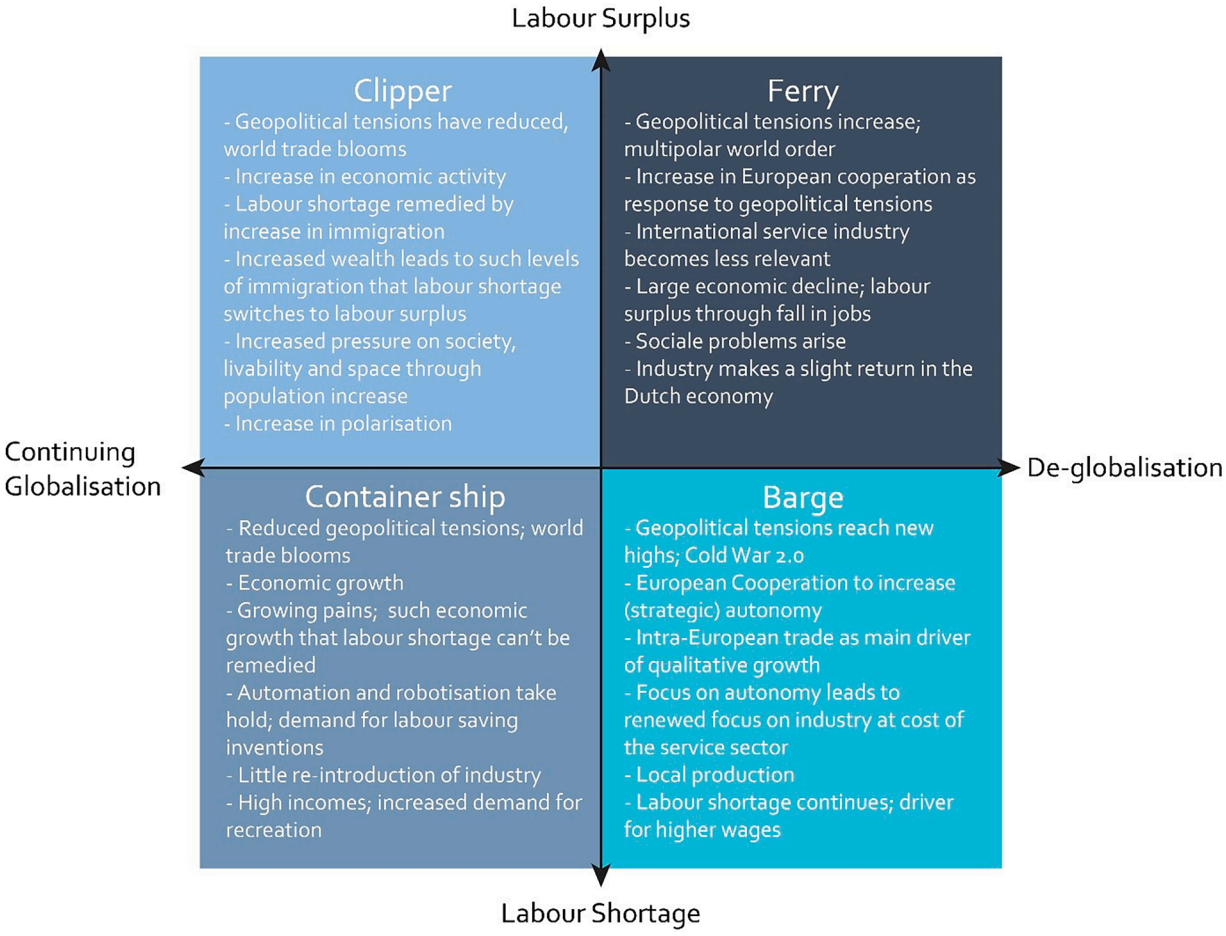

Fig. 1. Matrix showing produced scenarios (source: authors).

and - even with circular production - goods are imported.

While Scenario 1 focuses on globalisation and labour surplus, scenario Ferry explores the consequences of deglobalisation combined with a labour surplus. In this scenario, deglobalisation leads to economic hardships and societal unrest, with manufacturing slowly re-emerging as a key economic activity in response to reduced global trade. The conflict in Ukraine proved to be the clear demarcation between the open and closing world, and has only continued with an increased polarized world, challenging world dominance. In line with other recent reports on the possible consequences of a deglobalisation (e.g. Giammetti et al., 2022; HCSS, 2023), in this setting, Europe finds itself more isolated, even from the United States of America. The Netherlands, including the province of South Holland, are struggling to find their place in this new world where trade and international services have significantly decreased in importance (see also in this respect PBL, 2023b). These challenges, arising from an economic system that failed to adapt promptly to the new de-globalised situation, result in severe economic hardships. The scale of this economic decline is such that over time, there is a surplus of workers, as many logistical and service activities disappear. The economic downturn and the rise in unemployment further fuels societal unrest. At the same time, the manufacturing sector slowly but surely makes a comeback in the Dutch economy (cf. CRa, 2024). This reindustrialisation and the increase of the CE making better use of the available materials is an answer to the shortage of the international import of machinery and goods (cf. Haezendonck & Van den Berghe, 2020).

Scenario Container Ship presents a world that has further globalised, and in which the Netherlands experiences a labour shortage. The shocks brought about by COVID and global conflicts like Ukraine are now things of the past, and trade flourishes like never before. Businesses in the Netherlands are booming, further strengthening the country's position as a global oriented economy based on the service sector. But this growth also comes with growing pains, as the labour shortage has significantly increased due to this growth. The Netherlands tries to train and bring in people from everywhere, as well as retaining existing staff and increasing their productivity, yet the shortage persists. Immigration is no longer the way to coop with this shortage, as many places around the world experience economic growth. In turn, this gives an extra boost to the automation and robotisation of various processes and to the CE, making better use of the available goods and materials (see also in this respect PBL, 2023b). The cost savings that this can bring are an incentive for industries to start manufacturing in the Netherlands again (cf. Canello et al., 2022), although low-wage countries remain much more attractive for most production. The ongoing tightness in the labour market also has a positive impact on the income and

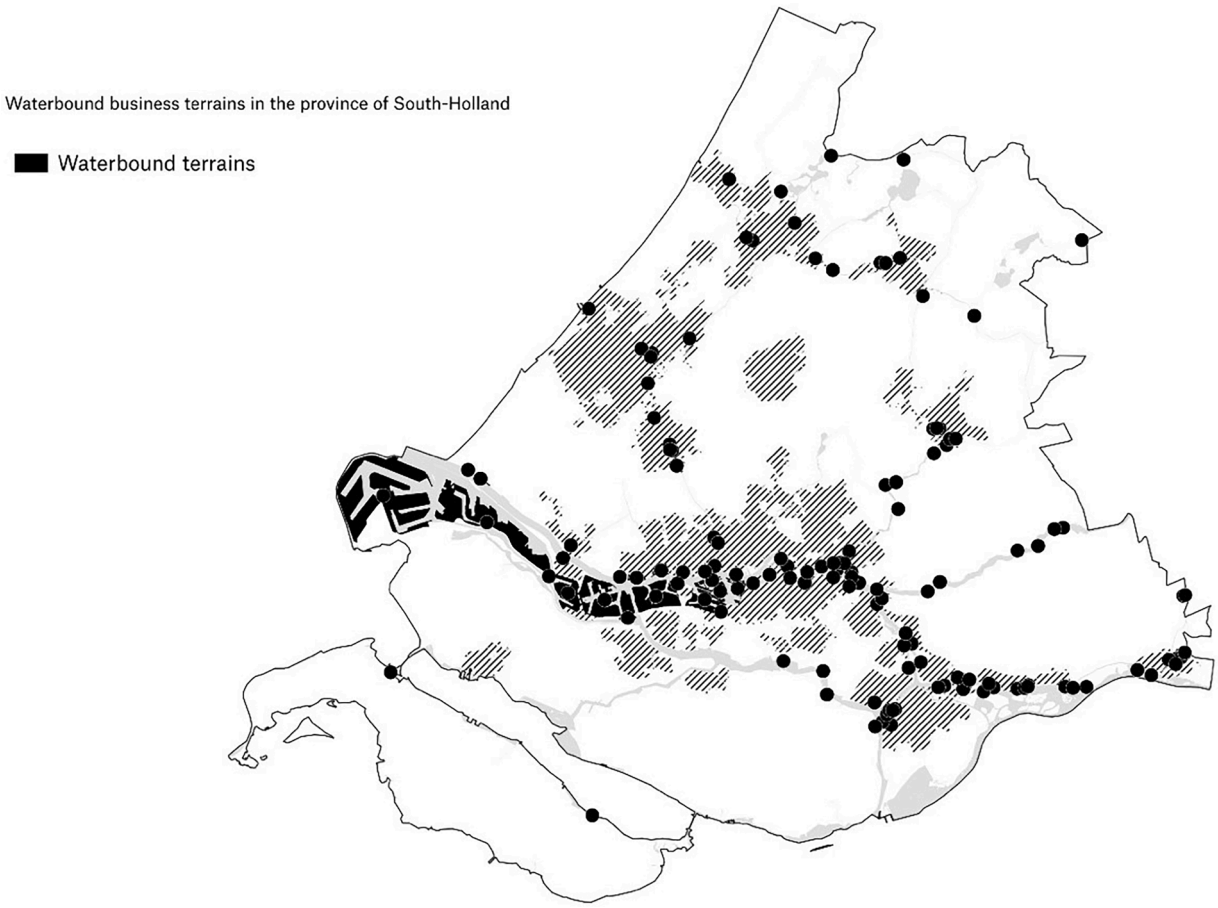

Fig. 2. Water bound industrial areas in the province of South-Holland. Because of the smaller size of industrial areas outside the port of Rotterdam, we used black dots to present these (source: authors).

purchasing power of many Dutch people. This, coupled with the need for much-needed relaxation stemming from the longer working weeks, makes people willing to spend more money on recreation, vacations, and other things to unwind or enjoy life.

Lastly, in scenario Barge, a future is foreseen where the world has deglobalized and the labour shortage is high. The end of the globalised world as known during the last half century is over. Several blocs have emerged that challenge the former USA dominance. The war has brought the EU member states closer together, further strengthening European cooperation and trade, allowing the continent to rely more on itself (HCSS, 2023). As world trade has decreased overall, but intra-European trade has continued to increase, there has been a shift from quantitative growth to relatively more sustainable and circular qualitative growth (cf. CRa, 2024). This growth is, however, slowed down by a severe labour shortage. The economic uncertainty has lowered the birth rate, immigration is at its lowest, and the consumption is low, having its effect on the economic growth too. Another reason is that the Netherlands, and particularly the province South-Holland shifted from a service sectoral to a more industrialised sectoral economy, creating a mismatch between the available work forces and the jobs. The CE is high to coop with the shortage of goods and materials, though not per se sustainable as the latter requires significant international R&D capital and knowledge, which have diminished. An upside is that the severe labour shortage has translated into higher salaries in general.

4.2. *Quantitative mapping of the situation today*

Of the total 617 industrial areas in South Holland, 143 areas have water bound transport capabilities (Fig. 2). As expected, the port of Rotterdam stands out, however, there are still 123 areas with quays located outside of the port of Rotterdam. Next, based on the LISA dataset, we mapped the amount of space used by CE activities, relative to the average provincial space use (Fig. 3). Our results show foremost industrial areas outside the port of Rotterdam. Looking at the detailed CE activities, we distinguished four 'types' of circular water bound industrial areas. First, industrial areas in and around Rotterdam have a focus on larger scale waste treatment. Further to the east, around the city of Dordrecht, the CE activities are dominated by ship construction. Among these is, for example, DAMEN Shipyards Group with multiple locations. Third, in the northwest, close to the cities of The Hague and Leiden, there are predominantly companies focussing on smaller scale repair (e.g. of cars), reuse, and waste treatment. Lastly, in the northeast close to Gouda, the focus is on construction materials.

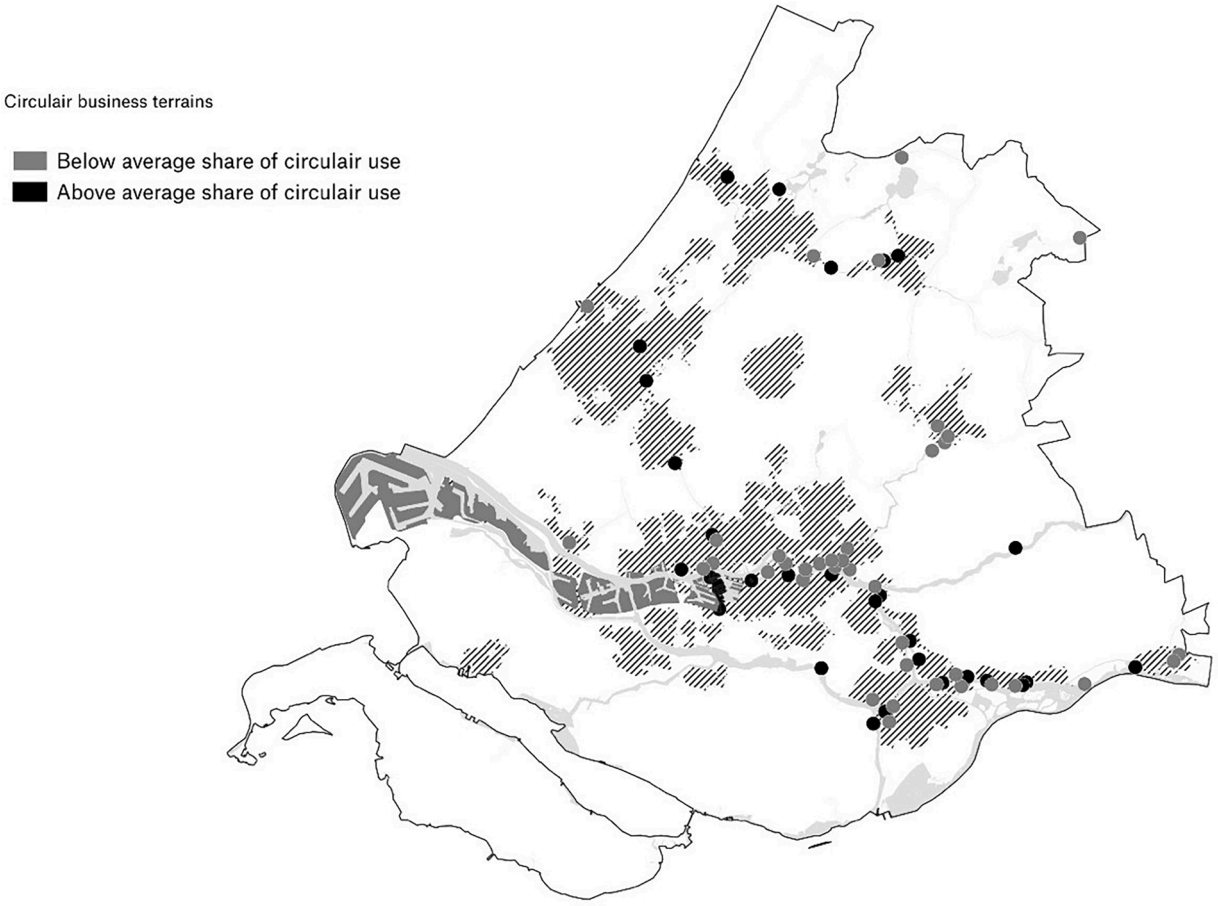

Fig. 3. Average share of circular use of business terrains in the province of South-Holland (source: authors).

A location of a CE activity at a water bound industrial area increases but doesn't ensure the use of water bound transport. Our analysis of the ship movements during the summer of 2019 revealed some important nuances. Fig. 4 presents the centrality of water bound industrial areas in South-Holland within the whole logistical network of ship movements. Fig. 4 shows two maps. The left includes and the right excludes the port of Rotterdam. While the total analysis is valuable, we excluded the port because it has significantly more ship movements, and, as such, it blurred our insights of the other industrial areas in the province.

Our results show some interesting aspects. First, for the whole province, the port of Rotterdam is arguably weakly connected to other industrial areas in the province. This to some extent shows that the port is foremost oriented towards its foreland and (further away) hinterland, and not so much connected to its immediate neighbouring region. Nevertheless, there is a connection, though interesting almost exclusively via one industrial area, cf. Distripark Botlek. In other words, the port of Rotterdam and the province are (almost) only connected via one water bound industrial area. Excluding the port of Rotterdam shows the important role of the water bound industrial areas more inland along the Rhine-Meuse river. The most central area is Stormpolder, situated along the Boven-Merwede in the municipality Krimpen aan den IJssel. Close by is de Groote Lindt in Zwijndrecht, and other areas in the municipality of Dordrecht. Also, in other parts of the province, some areas stand out, especially around Gouda. In general, we see that each major city in South-Holland has one or a few industrial areas that act as their main gate for water bound transport, though relatively in the network they remain mostly less important. Overall, we also see that many industrial areas are relatively low in the use of water bound transport, and, moreover,are not important in connection by water bound transport.

Finally, we cross-checked our centrality network with the spatial above-average analysis (cf. above 20% of the area is CE industrial activities) (Fig. 5). The first thing that is noticeable is that many of these areas are not or minimally using water bound transport, the former labelled as 'not in the network', and the latter with a high number. Conversly, we can see that some of the industrial areas that in general are very central in the network, are not hosting a significant amount of CE activities. For example, Stormpolder doesn't appear in this selection, nor does the Groote Lindt. Also, all areas around Gouda are missing. The areas with the highest ranking in centrality are Nieuwland-Nedstaal (place 4 in the centrality network), Wilheminahaven (place 12), 't Heen (place 13) and Binckhorst (place 21). Zooming in on these areas, we found that the Nieuwland-Nedstaal area only hosts one CE company, though a company that takes up a lot of area. For the Wilheminahaven, the LISA dataset shows that there is an important ship construction and reparation firm present, which according to the used definition, is regarded as circular. This also explains its high rank in centrality, as such company generates a lot and voluminous cargo, and is characterised by many local to regional processes. Other CE companies in this area are for example engineering firms. Finally, we want to highlight also the Binckhorst area in The Hague, as this area differs in characteristic with the others as it is inland and close or even within a major city located. The LISA dataset shows that the CE activities in the Binckhorst account for a major waste treatment plant located there. This waste treatment plant has a local character, but every few days it transports via a barge the residual waste to other areas in the province.

5. Discussion

The results of our scenario planning exercise indicate that three of the four scenarios suggest a significant increase in CE activities within the province of South-Holland. These scenarios highlight the importance of spatial planning in accommodating CE growth, with particular emphasis on water-bound industrial areas. The fourth scenario shows that the province could ignore the need for spatial CE

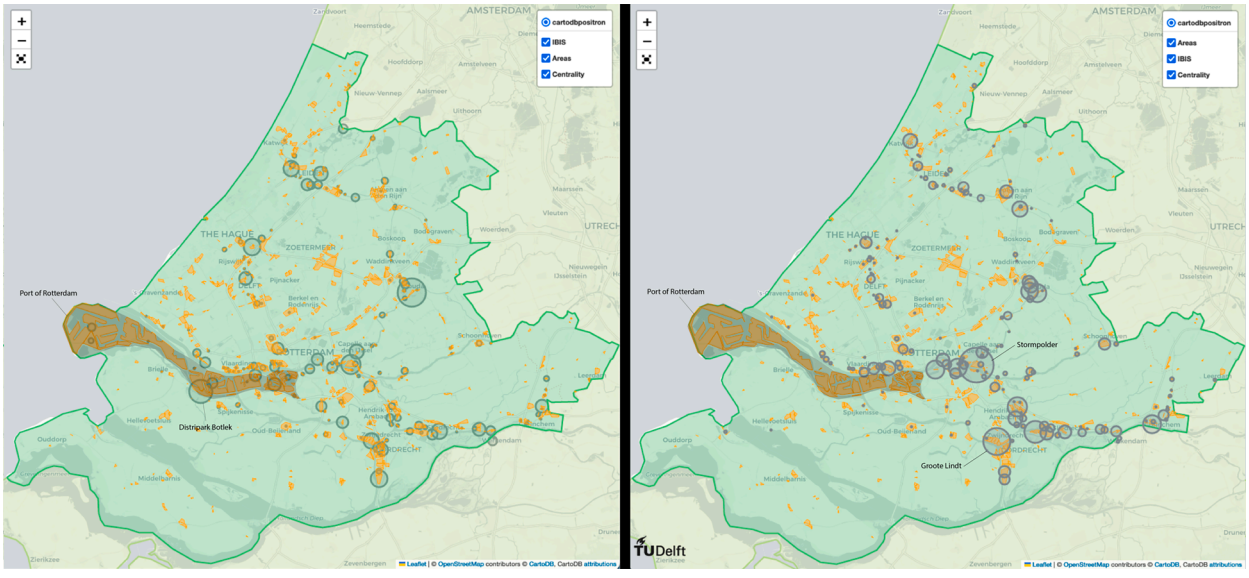

Fig. 4. Centrality map of water bound industrial areas in South-Holland, in 2019; left with all industrial areas included, right excluding the industrial areas of the port of Rotterdam (source: authors).

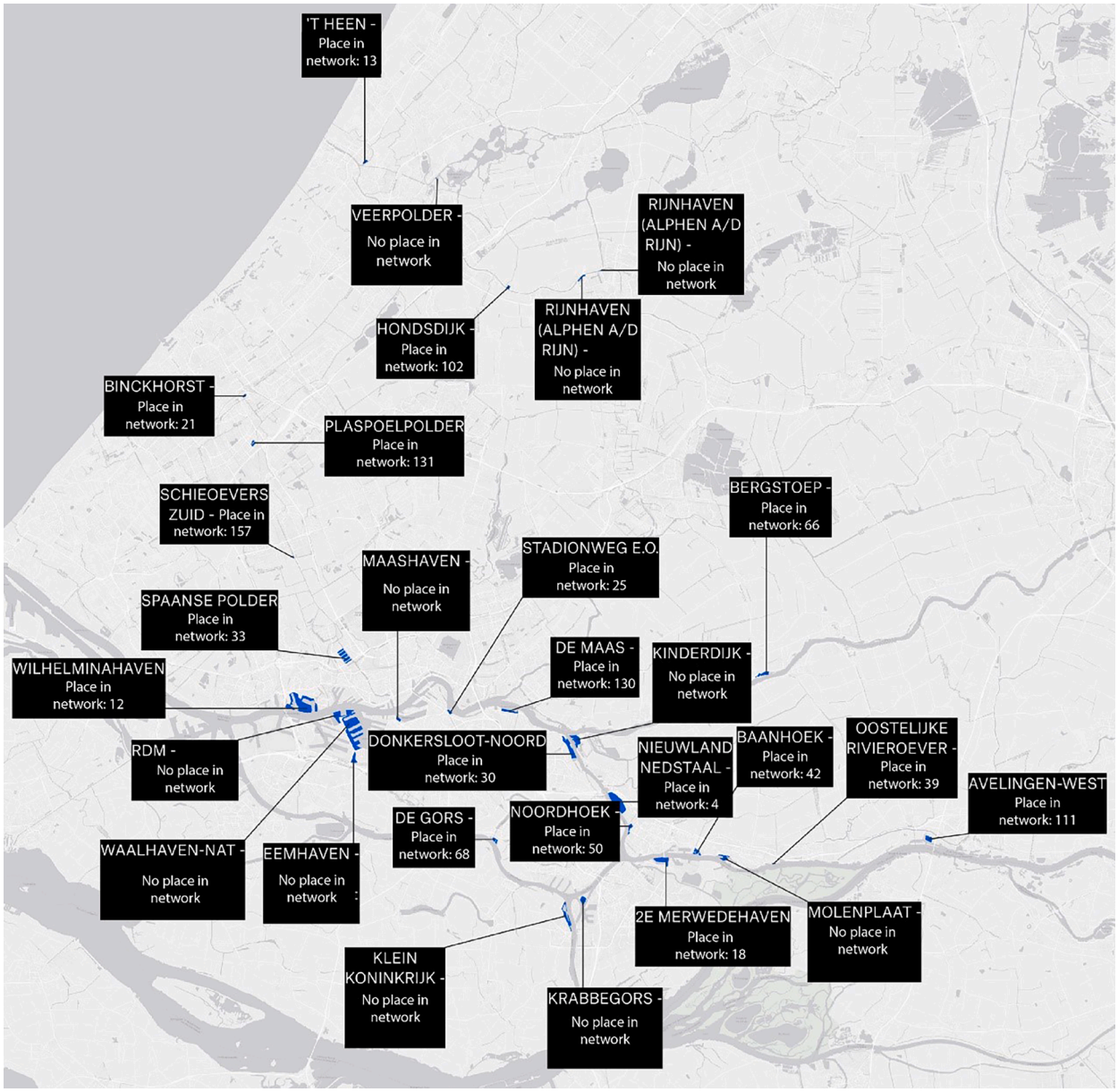

Fig. 5. CE industrial areas and their places within the network in the province of South-Holland (source: authors).

activities, as these would emerge outside the province and via logistical processes be imported and exported from further away, arguably like the contemporary situation. Accordingly, in three scenarios, the provincial authority has, to some extent, realised this upcoming need for space for the CE. At the moment, the Provincial authority doesn't allow a quantitative decrease of the amount of space for industrial activities. The only way industrial areas can be redeveloped, is by compensation somewhere else (Provincie Zuid-Holland, 2020). However, one could question the effectiveness of this measure. First, other agendas have equal rights to claim 'underused' industrial areas. Especially in and around cities, the need for housing is a pressing societal issue. Second, the measure doesn't guarantee that it safeguards the most valuable ones today. The latter is always arbitrary, especially because we don't know what a CE precisely entails, though we can use some assumptions. As explained, today the province of South-Holland is a highly urbanised region with saturated roads and railroads. If, even only slightly, CE activities increase in presence in the province, generating more forth-and-back cargo movements, this will only add to this saturation. Facilitating CE activities through water-bound transport can significantly alleviate the pressure on road and rail networks, offering a sustainable and efficient alternative for handling increased cargo movements. But even safeguarding all water bound industrial areas is not yet precise enough.

Our results suggest that policy makers should prioritize safeguarding key water-bound industrial areas that are integral to CE activities. First, there is a difference between the importance based on frequency and volume, and on the network importance. Quite

obviously, the port of Rotterdam's industrial areas score the highest on the former, but our analysis showed that these are not or almost not connected to other industrial areas in the province. Facilitating the CE in the province of South-Holland is thus more promising when considering what industrial areas outside the province play an important role. Here again, a difference exists between all activities included or only focusing on CE activities. Our analysis showed that most CE activities and industrial areas do not or almost not use water bound transport. And, if they do, it is mostly because of one company that generates a lot of water bound traffic in the province, such as a ship construction and reparation company or waste treatment plant.

Nevertheless, this information is insightful. We could in detail show almost on company level what is happening, and thus what location are today important in the CE, instead of regarding all 617 industrial areas as equally important; the latter having the risk subsequently that none of those are important. Our policy recommendations are therefore to try to understand, further analyse, and also safeguard the industrial areas that host today CE activities and are using water bound transport. These insights translate to several levels. They are insightful for the 'separate' land use policy of port, city, and region, but also regarding the connection between all these. Arguably, the network of connections is rather weak, and dominated by only one or a few industrial areas. If the port authority of Rotterdam would intervene with the Botlek Europoort Oost, or the municipality of Krimpen-aan-den-IJsel wants to redevelop Stormpolder into residential housing, this would directly have an impact on the network of water bound CE activities in the province.

6. Conclusion

In this paper, we have explored the intricate dynamics between the Port of Rotterdam and its hinterland through the lens of the CE, particularly under the cloud of current uncertain times. Our problem statement explained that hereby, we brought together two strands of literature. On the one hand the literature on the territorialization of the CE. We explained that if a spatial perspective is put at the centre in operationalizing a CE, quicker it will be clear who and where is responsible for the CE and subsequently what (difficult) choices must be made. This would first help to overcome greenwashing or a naïve optimistic belief of a CE, as it would more quickly become clear who or where problem externalization occurs, and at the same time who and where responsibility lies. Though, we also stressed that with this 'reality check', the uncertainty would increase, as it would more quickly become clear that there are no easy solutions, bur foremost difficult choices with uncertain outcomes. On the other hand, we introduced the literature on the role of ports in a CE. To some extent departing from their quantitative growth model of the past few decades, ports are now faced with the challenge of addressing ecological issues, creating more qualitative jobs, and, last but not least, contributing to new ways forward into an increasing geopolitical uncertainty.. The connection between the two strands of literature is thus uncertainty of operationalization a CE, by using the perspective of the spatial planning of ports.

Next, we explained how uncertainty has been developed within spatial sciences and focused on scenario methodologies. By employing an explorative scenario planning approach, we embraced the inherent uncertainties and developed four distinct scenarios to probe into the future of spatial planning within this context. Our research reveals that three out of four scenarios suggest a likely increase in CE activities within the province of South Holland, pointing towards a growing recognition of the need for spatial planning that accommodates CE principles. The findings underscore the significant yet variable role of water-bound transport in supporting CE activities across the region, highlighting the criticality of certain industrial areas over others in facilitating this transition. Our research has limitations, of course. First, we've used the SBI CE filtering that is not perfect as explained before. Second, our centrality of industrial areas based on volume doesn't exclude a ship can be empty, or only partially filled. Third, scenario methodology remains to some extent a speculative. As much as possible, we tried to back up our construction of these scenarios as much as possible with relevant sources and references, though it remains a qualitative exercise.

Ultimately, our paper argues for a nuanced understanding and strategic safeguarding of these key industrial areas to ensure their contribution to the CE transition. Thus, answering our main research question, we conclude that the CE transition necessitates a reevaluation and adaptation of spatial planning practices in port and hinterland regions, with a particular emphasis on leveraging water-bound transport networks to foster sustainable and resilient economic systems. This adaptation not only addresses the immediate needs of the CE but also aligns with broader goals of sustainable development and resilience in the face of ongoing global uncertainties. To conclude, we are convinced we are increasingly at a point where it is necessary to become more concrete of what a CE realization entails, to go beyond the 'win-win' narrative, and to seriously discuss the needed (spatial) choices and consequences. Our paper is only one and limited attempt to add to this discussion, though combining quantitative data (e.g. industrial ecology) with more qualitative and political information (e.g. political ecology or economy) should become leading. Then, the right choice of case studies, like ports or port cities (cf. Harrison et al., 2022), can help to get more rapid insights in what is going on, or what should be going on.

CRediT authorship contribution statement

Karel Van den Berghe: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Tanya Tsui:** Supervision, Data curation. **Merten Nefs:** Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Giorgos Iliopoulos:** Methodology, Data curation. **Chrysanthi Papadimitriou:** Methodology, Data curation. **Tom Fitzgerald:** Methodology, Investigation, Data curation. **Thomas Bonte:** Methodology, Investigation, Data curation. **Aryzo Arrindell:** Writing – original draft, Visualization, Validation, Resources, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Abou Jaoude, G., Mumm, O., Carlow, V.M., 2022. An overview of scenario approaches: a guide for urban design and planning. J. Plan. Lit. 37 (3), 467–487. https://doi.org/10.1177/08854122221083546.
Amer, M., Daim, T.U., Jetter, A., 2013. A review of scenario planning. Futures. 46, 23–40. https://doi.org/10.1016/j.futures.2012.10.003.
Avin, U., Goodspeed, R., 2020. Using exploratory scenarios in planning practice. J. Am. Plan. Assoc. 86 (4), 403–416. https://doi.org/10.1080/01944363.2020.1746688.
Baumgartner, J., Bassens, D., De Temmerman, N., 2024. Finding land for the circular economy: territorial dynamics and spatial experimentation in the post-industrial city. Cambridge J. Regions Economy Soc. https://doi.org/10.1093/cjres/rsae016.
Bauwens, T., Hekkert, M., Kirchherr, J., 2020. Circular futures: what Will They Look Like? Ecol. Econ. 175, 106703. https://doi.org/10.1016/j.ecolecon.2020.106703.
Bibri, S.E., Krogstie, J., 2019. Generating a vision for smart sustainable cities of the future: a scholarly backcasting approach. Eur. J. Futures Res. 7 (1). https://doi.org/10.1186/s40309-019-0157-0.
Blomsma, F., Brennan, G., 2017. The emergence of circular economy: a new framing around prolonging resource productivity. J. Ind. Ecol. 21 (3), 603–614. https://doi.org/10.1111/jiec.12603.
Blum, N.U., Haupt, M., Bening, C.R., 2020. Why "Circular" doesn't always mean "Sustainable". Resour. Conserv. Recycl. 162, 105042. https://doi.org/10.1016/j.resconrec.2020.105042.
Börjeson, L., Höjer, M., Dreborg, K.-H., Ekvall, T., Finnveden, G., 2006. Scenario types and techniques: towards a user's guide. Futures. 38 (7), 723–739. https://doi.org/10.1016/j.futures.2005.12.002.
Bradfield, R., Wright, G., Burt, G., Cairns, G., Van Der Heijden, K., 2005. The origins and evolution of scenario techniques in long range business planning. Futures. 37 (8), 795–812. https://doi.org/10.1016/j.futures.2005.01.003.
Burger, M., Stavropoulos, S., Ramkumar, S., Dufourmont, J., van Oort, F., 2019. The heterogeneous skill-base of circular economy employment. Res. Policy. 48 (1), 248–261. https://doi.org/10.1016/j.respol.2018.08.015.
Calisto Friant, M., Vermeulen, W.J.V., Salomone, R, 2020. A typology of circular economy discourses: Navigating the diverse visions of a contested paradigm. Resour. Conserv. Recycl. 161. https://doi.org/10.1016/j.resconrec.2020.104917.
Canello, J., Buciuni, G., Gereffi, G., 2022. Reshoring by small firms: dual sourcing strategies and local subcontracting in value chains. Cambridge J. Regions Economy Soc. https://doi.org/10.1093/cjres/rsac015.
Chakraborty, A., Kaza, N., Knaap, G.-J., Deal, B., 2011. Robust plans and contingent plans. J. Am. Planning Assoc. 77 (3), 251–266. https://doi.org/10.1080/01944363.2011.582394.
Chembessi, C., Bourdin, S., Torre, A., 2024. Towards a territorialisation of the circular economy: the proximity of stakeholders and resources matters. Cambridge J. Regions Economy Soc. https://doi.org/10.1093/cjres/rsae007.
Chermack, T., Lynham, S., Ruona, W., 2001. A review of scenario planning literature. Futures Res. Q.
COM. (2024). *The Future of European Competitiveness*.
Corvellec, H., Stowell, A.F., Johansson, N., 2021. Critiques of the circular economy. J. Ind. Ecol. https://doi.org/10.1111/jiec.13187. *n/a*(n/a).
CRa. (2024). *Toekomstbestendige havens in de Vlaams-Nederlandse Delta*.
Dabrowski, M., Williams, J., Van den Berghe, K., van Bueren, E, 2024. Circular Regions and Cities. Towards a Spatial Perspective on Circular Economy.Circular Regions and Cities [in press]. In: Van den Berghe, K., Dabrowski, M., Williams, J., van Bueren, E. (Eds.), Going circular: Unlocking the Potential of Regions and Cities to Drive the Circular Economy Transition. Taylor and Francis.
Dryzek, J., 1987. Rational ecology: Environment and Political Economy. Basil Blackwell.
[1989] Emel, J., Peet, R., 2001. Resource management and natural hazards. In: Peet, R., Thrift, N. (Eds.), New Models in Geography, p. 1.
EMF, SUN, & McKinsey Centre for Business and Environment. (2015). *Growth within: A circular economy vision for a competitive Europe*.
Faut, L., Soyeur, F., Haezendonck, E., Dooms, M., de Langen, P.W., 2023. Ensuring circular strategy implementation: The development of circular economy indicators for ports. *Maritime Transport Research, 4*, 100087. https://doi.org/10.1016/j.martra.2023.100087.
Flyvbjerg, B., Skamris Holm, M.K., Buhl, S.L., 2005. How (In)accurate are demand forecasts in public works projects?:The case of transportation. J. Am. Plan. Assoc. 71 (2), 131–146. https://doi.org/10.1080/01944360508976688.
Foster, M.J., 1993. Scenario planning for small businesses. Long. Range Plann. 26 (1), 123–129. https://doi.org/10.1016/0024-6301(93)90240-G.
Friedmann, J., 1986. The world city hypothesis. Dev. Change 17 (1), 69–83. https://doi.org/10.1111/j.1467-7660.1986.tb00231.x.
Giammetti, R., Papi, L., Teobaldelli, D., Ticchi, D., 2022. The network effect of deglobalisation on European regions. Cambridge J. Regions Economy Soc. https://doi.org/10.1093/cjres/rsac006.
Haezendonck, E., Van den Berghe, K., 2020. Patterns of circular transition: what is the circular economy maturity of Belgian Ports? Sustainability. 12 (21), 9269. https://www.mdpi.com/2071-1050/12/21/9269.
Hall, P., 1997. Modelling the post-industrial city. Futures. 29 (4), 311–322. https://doi.org/10.1016/S0016-3287(97)00013-X.
Hall, P., Jacobs, W., 2012. Why are maritime ports (still) urban, and why should policy-makers care? [Article]. Maritime Policy Manag. 39 (2), 189–206. https://doi.org/10.1080/03088839.2011.650721.
Harrison, J., Hoyler, M., Derudder, B., Liu, X., Meijers, E., 2022. Governing polycentric urban regions. Territ. Politic. Gov. 1–9. https://doi.org/10.1080/21622671.2022.2083011.
HCSS. (2023). *De Strategische Belangen van de Nederlandse Maritieme Maakindustrie*.
Hobson, K., 2019. Small stories of closing loops': social circularity and the everyday circular economy. Clim. Change. https://doi.org/10.1007/s10584-019-02480-z.
IPO. (2021). *IBIS bedrijventerreinen*. https://provincies.pleio.nl/groups/view/86a606a7-5989-429c-af9c-bd36404a2f7a/ibis-openbare-bestanden-groep/files/eb108365-1193-4c98-8936-9666c591f8d2.
Jabbour, C.J.C., Jabbour, A.B.L.d.S., Sarkis, J., Filho, M.G., 2019. Unlocking the circular economy through new business models based on large-scale data: An integrative framework and research agenda. Technol. Forecast. Soc. Change 144, 546–552. https://doi.org/10.1016/j.techfore.2017.09.010.
Jefferson, M., 2012. Shell scenarios: What really happened in the 1970s and what may be learned for current world prospects. Technol. Forecast. Soc. Change 79 (1), 186–197. https://doi.org/10.1016/j.techfore.2011.08.007.
Kadaster. (2022). *Basisregistratie Kadaster*. https://www.pdok.nl/introductie/-/article/basisregistratie-kadaster-brk.

Kębłowski, W., Lambert, D., Bassens, D., 2020. Circular economy and the city: an urban political economy agenda. Culture Organiz. 26 (2), 142–158. https://doi.org/10.1080/14759551.2020.1718148.
Kinnunen, P., Guillaume, J.H.A., Taka, M., D'Odorico, P., Siebert, S., Puma, M.J., Jalava, M., Kummu, M., 2020. Local food crop production can fulfil demand for less than one-third of the population. Nat. Food 1 (4), 229–237. https://doi.org/10.1038/s43016-020-0060-7.
Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221.
Kirchherr, J., Urbinati, A., Hartley, K., 2023. Circular economy: a new research field? J. Ind. Ecol. 27 (5), 1239–1251. https://doi.org/10.1111/jiec.13426.
Kirchherr, J., van Santen, R., 2019. Research on the circular economy: a critique of the field. Resour. Conserv. Recycl. 151, 104480. https://doi.org/10.1016/j.resconrec.2019.104480.
Kishna, M., Rood, T., & Prins, A.G. (2019). *Achtergrondrapport bij circulaire economie in kaart*.
Köhler, J., Geels, F.W., Kern, F., Markard, J., Onsongo, E., Wieczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M.S., Wells, P., 2019. An agenda for sustainability transitions research: State of the art and future directions. Environ. Innov. Soc. Transit. 31, 1–32. https://doi.org/10.1016/j.eist.2019.01.004.
Krähmer, K., 2021. Are green cities sustainable? A degrowth critique of sustainable urban development in Copenhagen. Eur. Plan. Stud. 29 (7), 1272–1289. https://doi.org/10.1080/09654313.2020.1841119.
Latour, B., 2022. Is Europe's soil changing beneath our feet? War Ecol. 2, 92–97.
Lehmann, H., Hinske, C., de Margerie, V., Slaveikova Nikolova, A., 2022. The Impossibilities of the Circular Economy: Separating Aspirations from Reality. Routledge. https://doi.org/10.4324/9781003244196.
Levinson, M., 2010. The box: How the Shipping Container Made the World Smaller and the World Economy Bigger. Princeton University Press.
LISA Founding. (2019). *LISA dataset*. https://www.lisa.nl.
Livesey, F., 2018. Unpacking the possibilities of deglobalisation. Cambridge J. Regions Economy Soc. 11 (1), 177–187. https://doi.org/10.1093/cjres/rsx030.
Martin, R., Gardiner, B., Pike, A., Sunley, P., Tyler, P., 2021. 2. Becoming "left behind": how places have grown apart. Reg. Stud. Policy Impact Books 3 (2), 29–51. https://doi.org/10.1080/2578711x.2021.1992168.
Moeremans, B., Dooms, M., 2024. Social license to operate: Factors determining social acceptance among local port community stakeholders. Maritime Econ. & Logistics. https://doi.org/10.1057/s41278-024-00297-x.
Niang, A., Bourdin, S., Torre, A., 2024. The geography of circular economy: job creation, territorial embeddedness and local public policies. J. Environ. Plan. Manag. 67 (12), 2939–2954. https://doi.org/10.1080/09640568.2023.2210749.
North, P., 2010. Eco-localisation as a progressive response to peak oil and climate change – a sympathetic critique. Geoforum. 41 (4), 585–594. https://doi.org/10.1016/j.geoforum.2009.04.013.
Notteboom, T., Pallis, T., Rodrigue, J.-P., 2024. Ports and the circular economy. In: Notteboom, T., Pallis, T., Rodrigue, J.-P. (Eds.), Port Economics, Management and Policy. Routledge.
Nygaard, A., 2022. The geopolitical risk and strategic uncertainty of green growth after the Ukraine invasion: how the circular economy can decrease the market power of and resource dependency on critical minerals. Circ. Econ. Sustain. https://doi.org/10.1007/s43615-022-00181-x.
PBL. (2019). *Outline of the Circular Economy*.
PBL. (2023a). *Integrale Circulaire Economie Rapportage*.
PBL. (2023b). *Vier scenario's voor de inrichting van Nederland in* 2050.
Pillkahn, U., 2008. Using Trends and Scenarios As Tools For Strategy development: Shaping the Future of Your Enterprise. John Wiley & Sons.
Postma, T.J.B.M., Liebl, F., 2005. How to improve scenario analysis as a strategic management tool? Technol. Forecast. Soc. Change 72 (2), 161–173. https://doi.org/10.1016/j.techfore.2003.11.005.
Provincie Zuid-Holland. (2020). *Bedrijventerreinenstrategie*.
Provincie Zuid-Holland. (2022). *Omgevingsbeleid-werkingsgebied Watergebonden bedrijventerrein*. https://opendata.zuid-holland.nl/geonetwork/srv/dut/catalog.search#/metadata/867d729f-a637-4572-ad2a-99b071eee74d.
Provincie Zuid-Holland. (2023). *Krachtig Zuid-Holland. Coalitieakkoord provincie Zuid-Holland 2023-2027*.
Riegelman, R., 1979. The fallacy of free extrapolation. Postgrad. Med. 66 (3), 189–191. https://doi.org/10.1080/00325481.1979.11715257, 194.
RLI. (2020). *Toegang tot de stad: hoe publieke voorzieningen, wonen en vervoer de sleutel voor burgers vormen*.
Sassen, S., 1991. The Global City. Princeton University Press, New York, LondonTokio.
Slack, B., 1993. Pawns in the game: Ports in a global transportation system [Editorial]. Growth Change 24, 579.
STEC. (2023). *Gemeentebenchmark Stec Groep: ruimtelijke strategie cruciaal voor realiseren circulaire economie*.
Tapia, C., Bianchi, M., Pallaske, G., Bassi, A.M., 2021. Towards a territorial definition of a circular economy: exploring the role of territorial factors in closed-loop systems. Eur. Plan. Stud. 1–20. https://doi.org/10.1080/09654313.2020.1867511.
TNO. (2022). *Kansen voor circulaire bouwhubs in de Provincie Zuid-Holland*.
Tooze, A. (2022, 26/10/2022). Welcome to the world of the polycrisis. *Financial Times*. https://www.ft.com/content/498398e7-11b1-494b-9cd3-6d669dc3de33.
Torre, A., Dermine-Brullot, S., 2021. The circular economy, solution for a sustainable territorial development. Indian J Regional Sci (forthcoming).
Tsui, T., Venverloo, T., Benson, T., Duarte, F., 2024a. Spatial optimization of circular timber hubs. npj Urban Sustainability 4 (1). https://doi.org/10.1038/s42949-024-00153-0.
Tsui, T., Wuyts, W., Van den Berghe, K., 2024b. Geographic information systems for circular cities and regions. In: De Wolf, C., Çetin, S., Bocken, N.M.P. (Eds.), A Circular Built Environment in the Digital Age. Springer International Publishing, pp. 21–40. https://doi.org/10.1007/978-3-031-39675-5_2.
van Asselt, M., van't Klooster, S., 2012. Foresight in action: Developing Policy-Oriented Scenarios. Routledge.
Van Bergeijk, P. (2022). Working paper No. 694. An update on world trade during the COVID-19 episode. *ISS working paper series*.
van Bueren, E., Buizer, M., Van den Berghe, K., Heijkers, B., Meijs, L.C.P.M., Verhagen, T., Dittrich, K., Sprecher, B., 2022. Perspectieven op circulaire gebiedsontwikkeling. Lessen uit de Binckhorst en andere gebiedsontwikkelingen.
Van den Berghe, K., Dabrowski, M., 2024. The window of opportunity for circular economy in Europe in the wake of the geopolitical turmoil: connecting scales and principles [in press]. In: Van den Berghe, K., Dabrowski, M., Williams, J., van Bueren, E. (Eds.), Going circular: Unlocking the Potential of Regions and Cities to Drive the Circular Economy Transition. Taylor and Francis.
Van den Berghe, K., Jacobs, W., Boelens, L., 2018. The relational geometry of the port-city interface: case studies of Amsterdam, the Netherlands, and Ghent, Belgium. J. Transp. Geogr. 70 (C), 55–63. https://doi.org/10.1016/j.jtrangeo.2018.05.013.
Van den Berghe, K., Louw, E., Pliakis, F., Daamen, T., 2022a. When "port-out – city-in" becomes a strategy: is the port–city interface conflict in Amsterdam an observation or a self-fulfilling prophecy? Maritime Economics & Logistics 25 (2), 330–350. https://doi.org/10.1057/s41278-022-00236-8.
Van den Berghe, K., Peris, A., Meijers, E., Jacobs, W., 2022b. Friends with benefits: the emergence of the Amsterdam–Rotterdam–Antwerp (ARA) polycentric port region. Territ. Politic. Gov. 11 (2), 1–20. https://doi.org/10.1080/21622671.2021.2014353.
Van den Berghe, K., Verhagen, T., 2021. Making it concrete: analysing the role of concrete plants' locations for circular city policy goals [original research]. Front. Built. Environ. 7 (136). https://doi.org/10.3389/fbuil.2021.748842.
Van den Berghe, K., Vos, M., 2019. Circular area design or circular area functioning? A discourse-institutional analysis of circular area developments in Amsterdam and Utrecht, The Netherlands. Sustainability. 11 (18), 4875. https://www.mdpi.com/2071-1050/11/18/4875.
van Eijkelenburg, W., & van Harn, E.-J. (2021). *Geopolitieke kansen en bedreigingen voor Nederland*.
van Oort, F., Ramkumar, S., Stavropoulos, S., Burger, M., Dufourmont, J., Thissen, M., 2018. Putting the Circular Economy to Work: Measuring Gross Employment Effects in the Netherlands, 1996-2015. Working Paper. *Working Papers*. Erasmus University Rotterdam.
Vergragt, P.J., Quist, J., 2011. Backcasting for sustainability: Introduction to the special issue. Technol. Forecast. Soc. Change 78 (5), 747–755. https://doi.org/10.1016/j.techfore.2011.03.010.

Wachs, M., 2001. Forecasting versus envisioning: a new window on the future. J. Am. Planning Assoc. 67 (4), 367–372. https://doi.org/10.1080/01944360108976245.
Williams, J., 2021. Circular cities: a revolution in urban sustainability. Routledge. https://doi.org/10.4324/9780429490613.
Wuyts, W., Marin, J., 2022. Nobody" matters in circular landscapes. Local. Environ. 27 (10-11), 1254–1271. https://doi.org/10.1080/13549839.2022.2040465.
Yeung, H.W.-c., 2005. Rethinking relational economic geography. Trans. Inst. British Geographers 30 (1), 37–51. https://doi.org/10.1111/j.1475-5661.2005.00150.x.
Yeung, H.W.-c., 2024. From regional to global and back again? A future agenda for regional evolution and (de)globalised production networks in regional studies. Reg. Stud. 1–12. https://doi.org/10.1080/00343404.2024.2316856.