CHAPTER 15

Dreaming about Houston and Rotterdam beyond oil and ship channels

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Introduction

On March 9, 1872, the steamship "Richard Young" was the first sea vessel sailing through the brand new *Nieuwe Waterweg* ("New Waterway") toward the port of Rotterdam. The happening was celebrated with a festive ceremony and speeches by public dignitaries, emphasizing the importance of the new ship channel for the economic growth of the port of Rotterdam. Although it took some years to overcome some childhood diseases of the channel (initially, the channel silted up quickly. This was only under control after 20 years), it would become a main asset indeed for the growth of Rotterdam as the largest port of Europe and a main industrial center.

Something comparable took place in Houston on November 10, 1914, when the US president Woodrow Wilson opened the Houston Ship Channel by pushing an ivory button from his desk at the White House, which was wired to a cannon in Houston. The event was celebrated with great fanfare and with high expectations regarding the transshipment and processing of the new "black gold" that was found in the immediate surroundings of Houston: oil.

Both cities became iconic examples and engines of the modern industrialized world. They include the largest (Houston) and second largest (Rotterdam) petrochemical industrial complexes of the world, playing a main role in the world economy as global hubs of the production, transport, and distribution of fossil fuels. This main role of fossil fuels has influenced the spatial composition of both urban regions seriously, from the dominating role of petrochemical industries to the omnipresence of oil-related infrastructures such as highways and freeways and extensive parking lots. Both urban regions can be considered "*global petroleumscapes*" (Hein, 2018) *par excellence*.

The development of these cities and their ports as industrial hubs is strongly related to the exhaustion and increasing vulnerability of the water-dominated, swampy territories in both urban regions. Both aspects are under pressure of the need of a transition, because of climate change, rising sea levels, and more extreme weather conditions, as well as

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because of the need of energy transition and building a new economy, based on a "*Third Industrial Revolution*" (Rifkin, 2011).

Of course, there are also many differences between the two cities. The climate conditions are very different when comparing the moderate climate of the Netherlands with the extreme weather conditions of Houston, where hurricanes and rainstorms might occur which are unknown in Northwestern Europe. Also, the urban morphologies of both cities show more differences than similarities: Houston as the city of "*one million acres and no zoning*" (Lerup, 2011) and Rotterdam as a prototype of the Dutch postwar "*Welfare city*" (Wagenaar, 1992). As a matter of fact, these cities represent two variations of building a modern industrial society, built on two different dreams, as we will see in this chapter.

Despite these differences, there are common challenges in both regions, which are: how to create conditions for a more sustainable and adaptive territory, as well as for a necessary but still uncertain process of economic transitions. The most important challenge is the *combination* of both: how can an adaptive approach to sea level rise be combined with the transition of the economy and energy supply? How can these two developments support each other? What would it mean for the main assets which were the central key for economic growth during the last century: the ship channels?

Let us see how this common challenge might result in new solutions and strategies, based on new dreams in both cases and on a new approach to the ship channels.

Building the dream of the modern industrial urban landscape

Both industrial urban landscapes are already the result of the mutual influence and support of building a hydraulic system on the one hand and urban and regional development on the other hand. In both cases, it was also the combination of environmental disasters and new economic driving forces which was responsible for new hydraulic interventions and new economic and urban development in both regions.

The growth of Houston as a seaport, originally mainly focused on the export of cotton, was enabled by its location at Galveston Bay: accessible by water, and relatively well protected against storm surges by the stretch of barrier islands (Fig. 1). This natural condition was a problem at the same time, because of the shallow character of the bay. The first attempt to improve the accessibility of Houston for larger sea vessels started already in the mid-19th century by digging the Houston Ship Channel (Blackburn, n.d.; Bradley, 2020). However, it was not deep enough to be really competitive with Galveston, which is directly located in deep water. But around the turn of the century, the chances of both ports changed because of two main reasons: the discovery of huge amounts of oil in Texas, and the 1900 hurricane, which showed the vulnerability of Galveston. Moreover, the relatively easy connection of Houston with the continental railroad network was a great

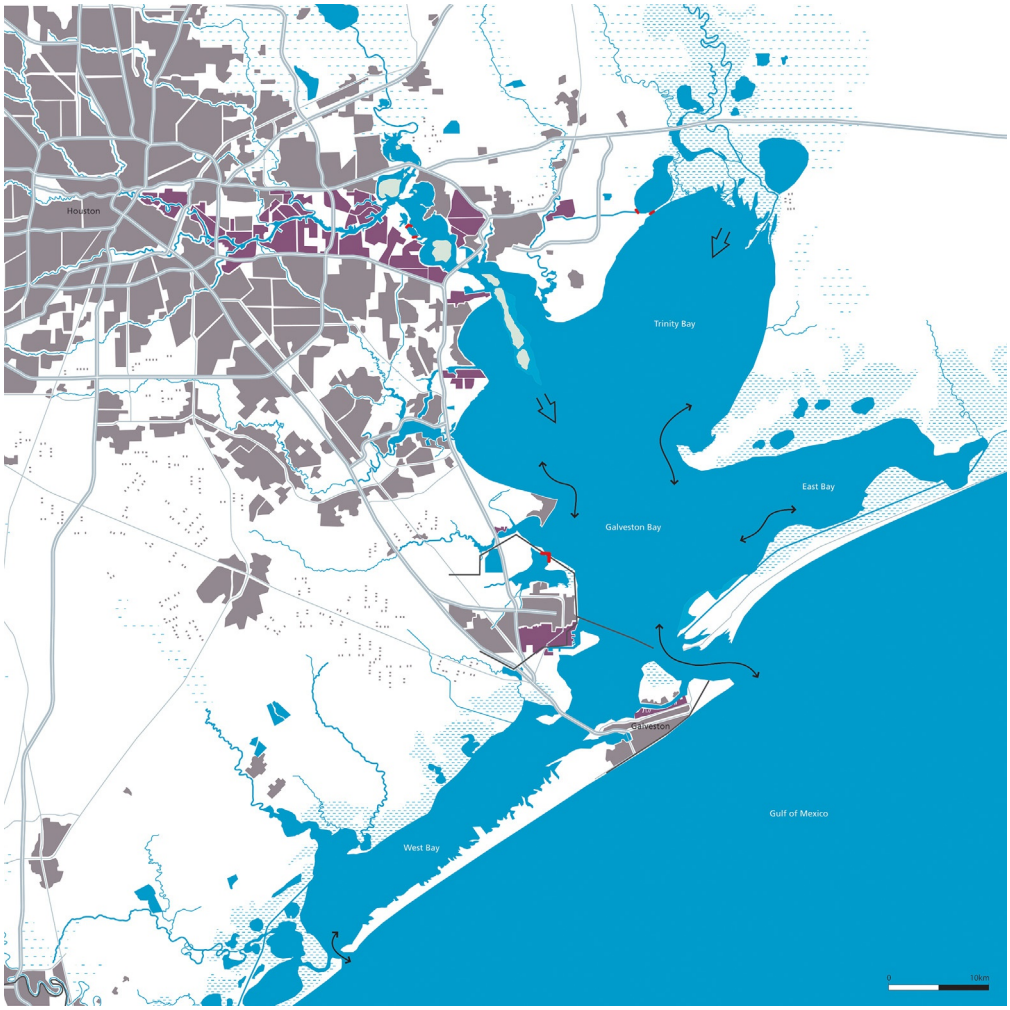

Fig. 1 Galveston Bay and Houston, 2000. *Grey*: urban, *purple*: port/industry. *(Map by MUST Stedebouw.)*

advantage. So the construction of the Houston Ship Channel was taken up again, now more seriously and radically, and supported by federal funding. The renewed Houston Ship Channel, dredged to a depth of 25 ft, was opened in 1914 with great fanfare in the city (Texas State Historical Association Website, n.d.). The channel was later hailed as "the port that built the city," making Houston the "Energy Capital of the World."

The combination of oil and the Houston Ship Channel was the key of the new, modern Houston not only because of the rise of more than five thousand energy related firms, including eight major refineries and 200 chemical plants producing a variety of synthetic

products (Texas State Historical Association Website, n.d.), but also because the city became a showcase of the American dream. The infinite and extremely cheap availability of oil created the condition for the maximum independency of every American: the urban layout is a system which provides everyone an own High Chaparral, with a maximum of freedom, autonomy and accessibility with his/her own automobile.

Oil seemed to enable Houstonians to get everything under control, including the swampy natural landscape of Harris County. In order to make the American dream come true, marshlands were drained, reclaimed, and changed into a landscape suitable for building the suburban world, including thousands of homes supported by federal money like the FHA[a] homes in Oak Forest, and for the extensive network of roads and freeways.

The growth of Rotterdam as a port city and the consequences for the landscape is largely comparable with the developments in Houston. Until the mid-19th century, Rotterdam was a modest port city at the river New Meuse, at 40 km distance from the sea. The New Meuse used to be the main discharge channel of the Rhine and Meuse, but was silting up since the 17th century. Since that time, the main discharge of the rivers was moving to the southern distributaries of the Rhine-Meuse delta.

The proposal of the engineer Pieter Caland to create a new connection between Rotterdam and the sea by digging a "New Waterway" was supposed to solve both problems: it should provide an easy and quick discharge of redundant river water, as well as an open access for large sea vessels to Rotterdam. The New Waterway was opened in 1872; however, it was not earlier than 1896 that the channel was deep enough for the largest sea vessels. From that moment, the port of Rotterdam was booming and became the largest port of Europe, specialized in the transshipment of bulk like coal, ore, and cereals. The New Waterway was considered a courageous venture and presented as one of the main assets of the Netherlands at the World Exposition in Antwerp in 1930.

After the second World War, and accelerated by the Delta Works after the flood disaster of 1953, the focus of the Port of Rotterdam shifted to oil. The new Delta Works were built not only to prevent a repeat of the 1953 flood, but also to contribute to the transformation of the Netherlands into a modern industrial society. The Delta Works provided a new infrastructure of highways and inland waterways. Especially important was that the Delta Works resulted in large freshwater basins, which were considered a crucial condition for the cooling installations of the new petrochemical processing industries in the port of Rotterdam. During the postwar decades, the industrial cluster in the Rotterdam port area increased to a vast complex including five refineries and 45 chemical plants, making Rotterdam the largest port of Europe and during the period 1962–2004 also the largest port of the world (see Fig. 2).

Oil and the Delta Works together were the key of the transformation of the Netherlands into a modern industrial society and a coherent nation-state. This last point was

[a] FHA = Federal Housing Administration. See Wright (1981).

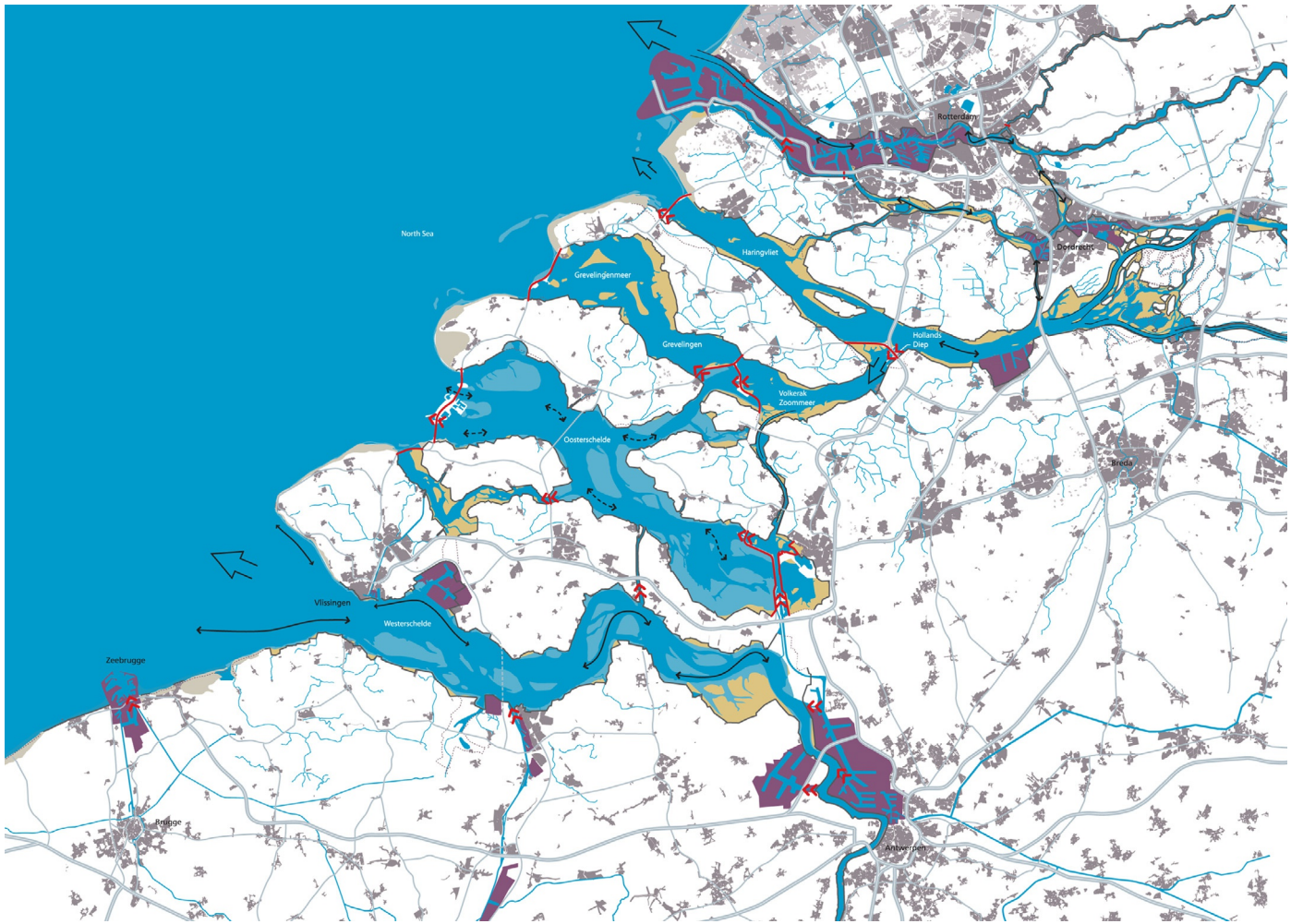

Fig. 2 Rhine-Meuse-Scheldt delta, 2000. *Grey*: urban, *purple*: port/industry. *(Map by MUST Stedebouw.)*

especially important in postwar Europe, including the Netherlands. It is true that European politics puts a strong emphasis on international cooperation, as a mean to avoid new wars between European countries. But at the same time, it was regarded necessary to pay more attention to national "team building" strategies by enhancing the national identity and pride in the different countries, as an optimistic alternative for the people, after the recent experience of the horror of war and fascist rule (Patel, 2020). In the Netherlands, an additional argument was the loss of the Dutch Indies, which gained independency in 1949. By that, the Netherlands had lost an important source of income as well as the idea of being a global empire. The Delta Works were considered an important bandage on the wound: these works provided the Dutch people a new reason for "*national pride,*" showing "*how a small country can be great.*"[b]

In the slipstream of the Delta Works, many books were published to underline the statement on the Delta Works as the new heroic achievement of the Dutch nation, with titles like "*Dredge, drain, reclaim. The art of a nation*" (Van Veen, 1948) and *"Nederland wordt groter"* ("The Netherlands is getting bigger") (Willems, 1962).

Thanks to the Delta Works, Rotterdam especially was getting bigger. Not only the reconstruction of the bombed city center and the new port areas, but also the new housing districts in the outskirts of the city became the showcases of the new postwar welfare state, built on reclaimed and intensively drained land and dominated by public housing and collective green areas.

So Houston and Rotterdam are two port cities in which two different dreams played an important role: in Houston, the American dream of maximum individual freedom; in Rotterdam, the dream of the European postwar welfare state with an emphasis on collective, national amenities. In both cases, the combination of oil and dredging, draining and reclaiming played a central role. The construct of frequent deepening of the ship channels especially was key to building two of these different showcases of modern urban society (see Table 1).

Cracks and fractures in the dream

The combination of oil and ship channels was not for everyone an obvious reason for blissful dreams. In the Rotterdam case, for example, there has always been doubts and warnings about the construction and frequent deepening of the New Waterway (Van de Ven, 2008). It was a trial-and-error intervention: experts disagreed with each other about the possible consequences of the new channel for river dynamics and influences of the sea on the hinterland. The doubts of opponents seemed justified, because the new river mouth was silting up again immediately and led to many headaches for the

[b] Prof. Jan Tinbergen, member of the Delta Committee, quoted in: Meyer (2017) p. 129.

Table 1 Comparison Houston-Rotterdam, 2020.

	Houston	Rotterdam
Land surface	City: 655 mi^2 (1696 km^2) Metro: 1778 mi^2 (4605 km^2)	City: 125 mi^2 (324 km^2) Metro: 315 mi^2 (817 km^2)
Population	City: 2.1 million Metro: 7.2 million	City: 650,000 Metro: 1.2 million
Gross domestic product	$472 billion (€395 billion)	$74 billion (€62 billion)
Dominating urban pattern	Low density detached houses	Medium density row houses
Average densities urban areas	10–25 persons/acre	20–80 persons/acre
Port transshipment	285 million ton	436.8 million ton
Territory	Low land (1–4 m *above* MSL) at bay area	Low land (1–4 m *below* MSL) in river delta
Climate	Warm maritime climate	Moderate maritime climate
Extreme weather conditions	With storm surges >27 ft (9 m) above MSL Extreme rainstorms	With storm surges >12 ft (4 m) above MSL Increasing draughts
Yearly precipitation	49.77 in (1264 mm)	34.65 in (880 mm)
Dominating urban pattern	Low-density detached houses	Medium-density row houses
Flood risk policy	Emphasis on emergency system, evacuation	Emphasis on flood prevention by extensive system of dikes and dams
Man-made interventions in water system	Houston Ship Channel, depth 45 ft (15 m)	Nieuwe Waterweg, depth 50 ft (16.5 m)

Based on data by public authorities Houston and Rotterdam, Port of Houston and Port of Rotterdam.

engineers of Rijkswaterstaat. It took another 24 years of intensive dredging and experimenting (including the invention and application of brand-new trailing suction hopper dredgers) before the first large-scale sea vessels could navigate through the channel and reach Rotterdam.

Also, the plan by the City of Rotterdam for building new oil terminals at the embankments of the New Waterway in the 1950s was not received with open arms by everyone. Johan van Veen, secretary of the former Delta committee and godfather of the Delta Works, was vehemently opposed to this plan. He warned about the uncontrollable consequences of making the New Waterway deeper and deeper, like salt intrusion, and increasing high water levels in the urbanized region. van Veen pleaded for new port development outside the coastline, where the coexistence of shallow sandbanks and deep

channels offered excellent conditions for the construction of a new deep-sea port (Van der Ham, 2020). Moreover, the Province of South Holland was opposed to the intentions of Rotterdam, because the development of a long industrial corridor alongside the New Waterway was considered an undesirable spatial dichotomy of the provincial territory. Also, the Minister of Water Affairs was opposed to the Rotterdam plan, but relented finally for the pressure and economic arguments of the Rotterdam lobby (Lucas, 1957).

Enhancing the role of the New Waterway as the main entrance for the industrial post-war port of Rotterdam involved a step-by-step deepening of the channel, from 3 m (9 ft) in 1872 to the current depth of 16.5 m (50 ft). Next to serious pollution of the water, this process of deepening resulted in an increase of influence of the sea on the hinterland, including a growing tidal amplitude (Paalvast, 2014) and increasing salt intrusion. In order to stop salt intrusion, the discharge of the whole river system in the Netherlands is tuned to maintain maximum pressure on the New Waterway.

And finally, from the 1990s, climate change and rising sea levels accelerated the urgency to reconsider the approach to the ship channel—not only in Rotterdam, but also in Houston and many other port cities.

The year 2008 was a crucial year for Houston as well as for Rotterdam. In that year, Houston experienced the devastating consequences of Hurricane Ike, which could have been much worse if the eye of the hurricane would have passed some more miles to the west. The vulnerability of the industrial complex of refineries and chemical plants, provisionally protected with small dike rings, became visible. It made clear that the lack of a solid and collective protection against storm surge means an irresponsible risk for the life of millions of Houstonians, for the natural environment, and for the US energy supply. Although the role of the Houston Ship Channel was never questioned as a risk-increasing factor (as far as I can check), it is clear that the channel itself is also very sensitive and vulnerable to storm surges. The arduously deepened channel in the mid of the shallow Bay will be silted up seriously after a storm surge.

Hurricane Ike and also Harvey in 2017 especially addressed the vulnerability of the confluence of the Houston Ship Channel with the lower Buffalo Bayou. This is the most industrialized part of the channel and the most vulnerable at the same time, because of the compound flood events, combining the discharge of redundant rainstorm water by the Buffalo Bayou and a storm surge via the Houston Ship Channel, resulting in extremely high water levels (Couasnon, Sebastian, & Morales-Nápoles, 2018; Liu, 2017).

In the Netherlands, 2008 was the year in which a new national Delta Committee presented a report with an analysis of the possible consequences of climate change for the increase of flood risk, along with recommendations of the government. The result was the installation of the Delta Program 1 year later, with a special governmental Delta Commissioner who can dispose of an additional yearly budget of one billion euro until 2030. The adage of the Delta Committee was expressed in the title of its report:

"working together with water," referring to the need to understand and make use of the dynamics of natural water systems instead of fighting against these dynamics (Delta Committee, 2008).

One of the most important and complex questions, addressed by the Delta Committee and to be solved by the new Delta Program, was the Rhine mouth region. It is the most densely urbanized and industrialized region of the Netherlands, struggling with three water problems at the same time: sea level rise, increasing peak discharges of the rivers, and a shortage of retention capacity to be able to deal with the intensification of rainstorms.

It is true that the storm surge barrier *Maeslant*, built in the 1990s, gives protection against storm surges which lead to water levels of more than 3 m above MSL in the urban area of Rotterdam. However, there are many not embanked areas in the floodplain which will also be flooded with a water level between 2.5 and 3 m above MSL. Moreover, because of rising sea levels, the expectation is that the Maeslant barrier will have to close several times a year in the future, which will have negative consequences for navigation and the port.

Next to increasing awareness of climate change and rising sea levels, 2008 was also a pivotal year for another reason. A period of boisterous economic growth came to an end abruptly thanks to the financial and economic crisis. This crisis accelerated the discussion on the causes and effects of the environmental and climate crisis. Both the economic and the climate crises cast a dark shadow on the dreams of prosperity and welfare thanks to the industrial economy and came together in the debate on the necessity of what economist Jeremy Rifkin called the "Third Industrial Revolution" (Rifkin, 2011). Energy transition and building a circular economy should be the central goal of this revolution, with one common characteristic: a farewell to fossil fuels. For Houston as well as Rotterdam, this would have drastic consequences: how to change these two economies largely built on the trade and processing of fossil fuels?

Some other industrialized areas in the United States and Europe showed already earlier that it might be smart to develop a strategy for the time when heavy industries will change, move, or disappear. Detroit, "Motor Town" of the world, has become an example of what can happen if a city is too much dependent on one dominating industry and never thought about any strategy for economic transition. It has led not only to economic decay and mass unemployment, but also to a collapse of the city and urban life, which has become proverbial.

The German Ruhr area, once the largest industrial center of Europe, experienced the departure of the steel factories and the closing of the coal mines in the 1980s and 1990s, but transformed the industrial landscape into a large complex of public parks, museums, and theatres and attracted new industries, specialized in smart and sustainable technology. Currently, the Ruhr area is the second largest tourist destination of Germany and has developed a diversified economy with a strong presence of knowledge-based services and industries. It still is the most important contributor to the GDP of Germany (Website European Commission, n.d.).

For Houston as well as for Rotterdam, the urgent question is how to avoid a pathway like Detroit and how to prepare a pathway more similar to the Ruhr area.

Creating new perspectives: The ship channel as a leverage

The previous considerations make clear that cities like Houston and Rotterdam are facing a complex challenge, which includes as well the need of mitigation by changing the fossil-based industrial economy as the need of adaptation to the rising sea level and increasing precipitation quantities. A call for an "integrated" approach is tempting, but it will be incredibly difficult to share all different stakeholders and interests of both tasks under one umbrella. Both processes, the transition of the industrial economy and the adaptation to changing water conditions, will have their own dynamics and speeds, which cannot be organized totally parallel.

Concerning adaptation, there is a rising common sense of urgency in Rotterdam as well as in Houston. This book provides one example of this growing awareness. The responsible main actors in both cases are, for example, Rijkswaterstaat, the city of Rotterdam and the Delta program in the Netherlands; and the US Army Corps of Engineers, the city of Houston, and the Houston Resilience strategy in the Houston area, as well as a range of academic institutions. These actors are fully focused on the question of how and where adaptation measures can be applied and how they can be organized and financed.

Concerning energy transition and the change from fossil fuels toward more sustainable and recyclable energy sources, the question is not *if* it will happen but especially *when* and *how* it will happen, and how quick or slow this transition process will be. Concerning the "how" of this transition process, it is getting clear that a strategy for new economic investments and projects should fit in and contribute to a process of making the deltaic landscapes more sustainable, instead of reversed.

From this point of view, interesting proposals in this direction have been developed during the last decade.

Recently, the Dutch Delta program launched its *Kennisprogramma Zeespiegelstijging* (Knowledge program sea level rise), which addresses three fundamentally different approaches for the Netherlands to sea level rise in the future: (a) a "sea ward" approach, extending an "offensive" approach with large-scale hydraulic works; (b) a "maintaining the existing coast line" approach, with as much as possible nature-based solutions, and (c) a "withdrawal" approach, intending to move most of the urban and economic centers of the Netherlands from the lowlands in the west to the higher grounds in the east of the country (Website Deltaprogramma, n.d.). An important question is, which approach would create the best conditions for a strategy of mitigation, energy transition, and an enhancement of the natural environment and biodiversity.

The "sea ward" approach means a continuation and intensification of the approach to manipulate and control the delta as an artificial infrastructure. It will mean incredible investments in new dams, locks, pumping stations (to pump the river water to the sea) and will make the future of the country completely dependent on the maintenance and frequent enhancement of this infrastructural system.

The "withdrawal" approach is a rather fatalistic one, which will lead to unbelievably costly operations to move the whole economic, industrial, and urban infrastructure 200 km to the east.

The "maintaining the existing coastline with nature-based solutions" approach seems to be the most promising and realistic one as well as the most sustainable one. This approach tries to explore in what sense the natural dynamics of water systems can be used to create safer conditions for human settlement, building upon the adage of the Delta Committee of "working together with water."

The City of Rotterdam, Port of Rotterdam, and nature conservation organizations such as World Wildlife Fund and ARK Nature development launched a program for the restoration of tidal nature at the embankments of the river: "*The river as a tidal park*" (Website City of Rotterdam, n.d.). For the time being, this program focuses on the embankments of the river and not on the restructuring of the riverbed as a whole. But it is not so difficult to imagine that it will take just one step further to address a more radical repair of the river mouth as an estuary, including a gradual transition of land to water and a substantially more shallow riverbed.

Building on this initiative, we proposed the Delta program to investigate the possibilities and perspectives of an approach to change the New Waterway in an estuary, by allowing the natural process of sediment transport and deposits to silt up the river mouth (Meyer and ARK Natuurontwikkeling, 2020). The expectation is that it will lead to an increase in biodiversity, less extreme high-water events in the urbanized area, less salt intrusion, new possibilities for leisure and recreation areas, and new urban environments. Port and navigation activities will not disappear but should change and adapt to the new environmental conditions. It will function as an accelerator of the necessary transition of the port from an oil-based energy supplier to a supplier of zero-fossil energy (Website World Wildlife Fund, n.d.). The New Waterway will be transformed from a monofunctional industrial shipping channel into a multifunctional estuary with space for biodiversity, recreation, new urban environments, making use of natural processes of sediment transport, and creating conditions for a new type of sustainable port system (Fig. 3). This transformation of the New Waterway will mean that the main discharge of the rivers should be redirected toward the southern estuaries of the delta. The "Delta Design Studio" of the Delta program showed the possibility and desirability of this change already in 2012 (Website Rijkswaterstaat, n.d.) (Fig. 4).

Concerning the Galveston Bay area, a comparable variety of different approaches has been developed. On the one hand, there is an approach that focuses on the enhancement

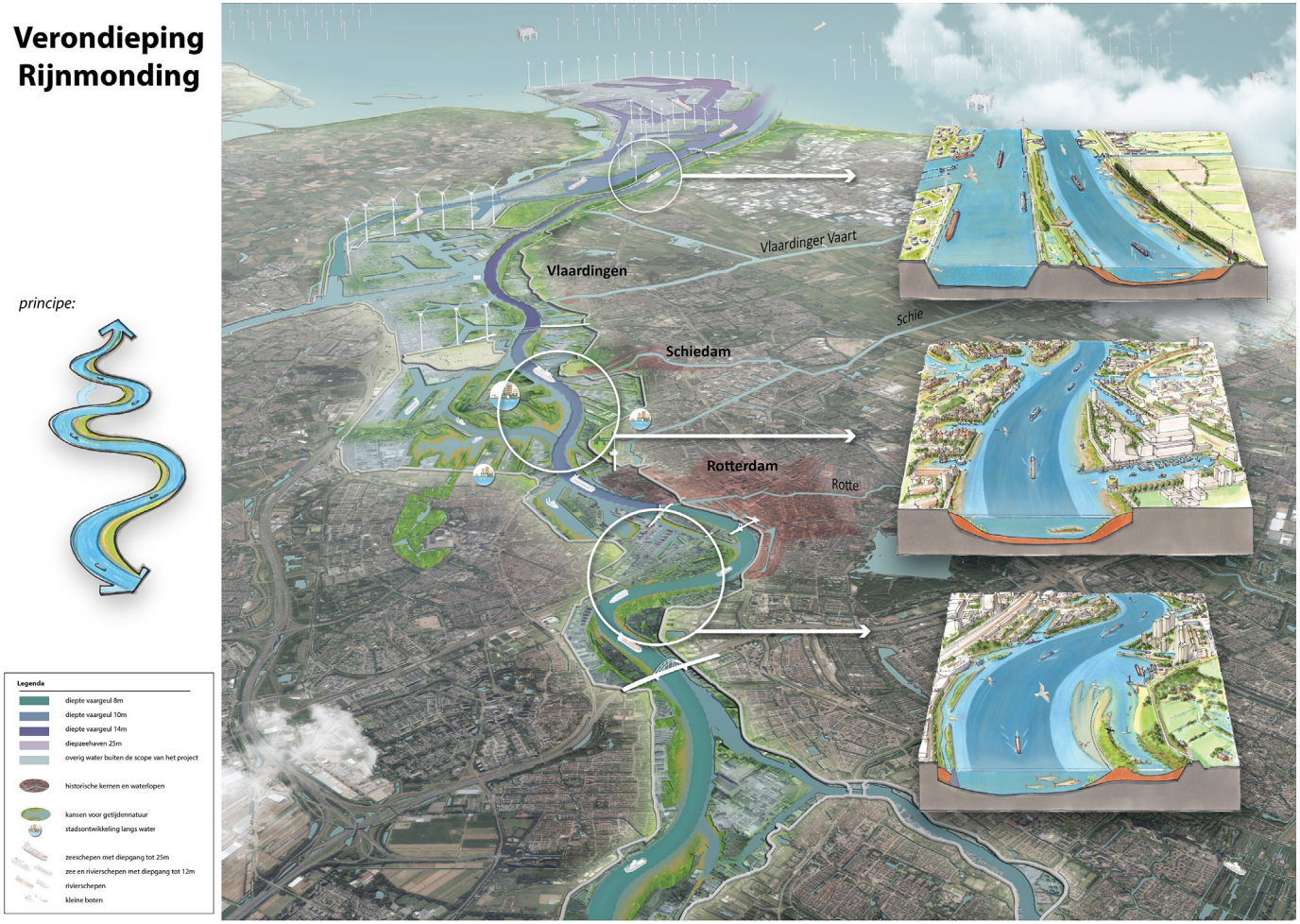

Fig. 3 The Rhine mouth as an estuary, by making the riverbed of the New Waterway more shallow and wider. *(Drawing by Dirk Oomen en Peter Veldt (Bureau Stroming).)*

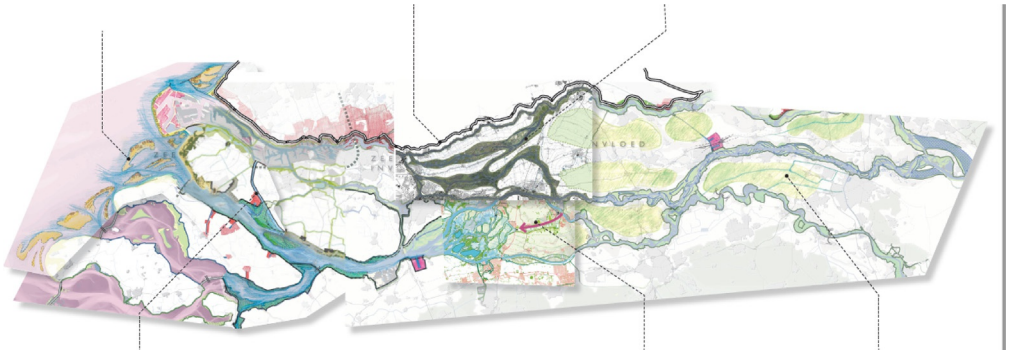

Fig. 4 Design study exploring the Haringvliet estuary as the new main discharge channel of Rhine and Meuse, reducing the role of the New Waterway in the discharge distribution. Design by H+N+S Landscape Architects, commissioned by the Dutch Delta program, 2012.

of the Texas coastline, with an emphasis on building a storm surge barrier in the sea gate between Galveston Island and Bolivar Peninsula. This approach culminated in the recently presented Coastal Texas Protection and Restoration Study by the US Army Corps of Engineers (USACE, 2020).

Another approach, focusing on the restoration of the Galveston Bay area, has been advocated by professionals and academics from Houston University, like the teams of Thomas Colbert (2014) and Peter Zweig (Zweig, Johnson, & Logan, 2020). They explored the possibilities to transform the Galveston Bay and Houston region into a multifunctional landscape, creating conditions for restoration of the natural environment, public facilities for recreation and leisure, and housing districts with public access to the beaches and wetlands of Galveston Bay. Also, student projects of TU Delft in the Houston region in 2014–15 and 2017 show interesting starts to develop nature-based approaches to create more safety against storm surges and rainstorms (Godfroy, 2017; Kothuis, Brand, Sebastian, Nillesen, & Jonkman, 2015).

The recently published *Galveston Bay Park Plan* (SSPEED Center et al., 2019) builds largely upon this idea. (Fig. 5). It shows the possibility of a new protection system by combining a new layout of the Houston Ship Channel with an extensive wetland restoration program. The renewed wetlands contribute to the safety of Houston against storm surges and also create a new publicly accessible landscape, as a condition for building a new future for Houston as a "*Post-industry, Post-oil, Post-sprawl*" urban landscape (Zweig et al., 2020).

As has been stated in the Galveston Bay Park Plan, this proposal should not be considered an alternative for or competitive with the USACE Coastal Texas study. Both plans could be regarded as complementary to each other. But for creating conditions

Fig. 5 Galveston Bay Park Plan, 2019. *(Map by SSPEED Center, Rogers Partners, Walter P. Moore, 2019, Galveston Bay Park plan, Houston.)*

for a radical transition of Houston and its economy in the future, the Galveston Bay Park Plan has the best cards.

Conclusions

Houston and Rotterdam both find themselves at a crossroads. Both urban regions have to wonder how they can organize two essential changes: a fundamental adaptation to climate change by nature-based solutions, and an economic transition from a primarily oil-based industrial economy to a more diversified and circular economy. In both changes, and especially in the combination of both changes, the ship channels play a key role.

The construction of both channels, more than a hundred years ago, played a key role in the realization of dreams on a new society of prosperity, built on oil and industrialization. But they also played a key role as a part of the problem of rising water levels and floods. Today, we need new dreams about a new type of urban society and economy with a new relation to the natural environment. Houston as well as Rotterdam can become guiding cities, showing how this dream can look like and how they can be realized. The *Galveston Bay Park Plan* and the *Rhine mouth as an estuary* are two first steps in making these dreams come true.

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