# REDEVELOPMENT OF TRANSPORT INFRASTRUCTURE AS DRIVER FOR ACCELERATING SOCIETAL TRANSITIONS.

## A REGENERATIVE PERSPECTIVE ON INFRASTRUCTURE PLANNING

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### Introduction

The planning and development of transport infrastructure networks increasingly involves environmental degradation, climatic impacts and societal trends. However, infrastructure planning has mainly focused on the gradual improvement and expansion of transport infrastructure networks themselves. In practice, infrastructure planners have rarely reflected on the role of infrastructure networks in enabling or constraining broader sustainability transitions. This may be about to change. In many Western countries transport infrastructure networks have been developed in the early to mid-twentieth century and much infrastructure approaches its 'best before' date and enters the phase of transition and renewal. That much transport infrastructure is physically deteriorating and changing as a result of ageing is clear: in the USA a considerable part of the 1 trillion dollar Infrastructure Plan of the Biden administration will be invested into infrastructure renewal, in Germany plans are afoot to increase investments into the renewal of the railway network of over 50% up to 86 billion euro, and in the Netherlands the Replacement and Renovation Program of Rijkswaterstaat of 1 billion euro a year is expected to grow vastly (Hijdra et al., 2015). The significant need of infrastructure refurbishment presents a 'window of opportunity' to broaden the infrastructure redevelopment options in order to enable wider sustainability transitions. That is, transport infrastructure renewal could create conditions favouring, for example, on-going transitions such as the energy transition or the transition towards a circular economy. A growing amount of literature emphasizes that investments in the transport infrastructure network can be utilized as a driver for accelerating wider transitions (e.g., Hijdra et al., 2015; Leendertse et al., 2016; Arts et al. 2021). Given the fact that transport infrastructure investments are often location-specific and project-based, it is important to not only focus on the institutional conditions of the infrastructure system in isolation, but more focus on how transport infrastructure renewal projects relate to spatial developments instigated on the basis of transitions in other systems.

This paper wants to raise a discussion in planning to utilize transport infrastructure as a means to accelerate social transitions through regeneration – using infrastructure as an underlying facilitating structure for joint infrastructure and area development. For this discussion we will use recent PhD research carried out within the Faculty of Spatial Sciences of the University of Groningen. This Faculty has a strategic partnership with Rijkswaterstaat, the main infrastructure manager in the Netherlands with regard to road and water infrastructure. Under the strategic partnership, several PhDs have been

completed since in the last decade. We use the evolution of the subsequent PhD researches to support our arguments for the discussion in this paper.

As the main theme in the development of the respective studies, two issues at the interface of infrastructure planning and spatial planning are dominant:

- The importance of integration as a basis for planning i.e., transport infrastructure and area planning not as separate approaches but as an integrated planning approach;
- The utilization of infrastructure as a structuring element in this integrated planning approach.

## The challenge of infrastructure redevelopment

The planning and realization of transport infrastructure is intrinsically related to processes of change. In addition to the fact that the planning and realization of transport infrastructure takes place in a changing environment, and that infrastructure itself induces change in that environment, the use of the infrastructure itself is also subject to change. Vehicles are becoming more and more autonomous, while logistics and mobility are intertwined, mobility is increasingly taking place on-demand and new forms of shared transport are emerging. This leads to all kinds of new transport configurations. Finally, even one of the most robust elements in infrastructure planning, the physical network, appears to be subject to change due to (accelerated) aging and wear because of more intensive and different traffic as well as changing climate conditions. Today, implementing the replacement and renewal of outdated transport infrastructure is seen as one of the biggest challenges in infrastructure planning.

To illustrate this challenge, in the Netherlands alone, this involves at least 85,000 bridges and viaducts, 3,000 kilometers of quays and sheet piling and 130,000 small civil structures, such as weirs and culverts. About 20 percent is in the hands of the central government (i.e., the main transport infrastructure network), the other 80 percent belongs to municipalities, provinces and water boards. In the Netherlands, more than 1 billion euro a year is currently spent on the renewal of civil infrastructure. A recent study (I&W, 2018) expects this amount to gradually increase to 3 to 4 billion euro in 2040-2050. In total, approximately 50 billion euros more will be needed over the next three decades for the renewal of the Dutch transport infrastructure.

Traditional maintenance focuses on the (one-to-one) replacement of old and worn parts in order to leave the existing situation intact as much as possible. At the same time, we also see that at the moment an intervention must be made in the infrastructure network, the question arises whether the intervention is an opportunity for improvement of the existing spatial situation in order to achieve a quality improvement – i.e., sustainable (re-)development. Willems (2018) describes (based on I&M, 2016) *three approaches to renewal* (NB: his study he focuses on waterway renewal; see Figure 1). First, the "one-to-one renewal" approach entails the replacement of individual infrastructure assets executed one-by-one by the national government, in which the functionality remains untouched. Second, the "minor renewal" approach involves a change in functionality on the local scale, resulting in the involvement of a greater number of local stakeholders. Likewise, transactions with these parties may result in covenants in which the national government facilitates additional aims of regional and local parties. Third, the "major renewal" approach considers the replacement of specific assets as part of wider spatial, regional developments. Transactions, then, operate on a larger geographical scale with more distant stakeholders. In the three approaches the value pursued shifts from sectoral to societal.

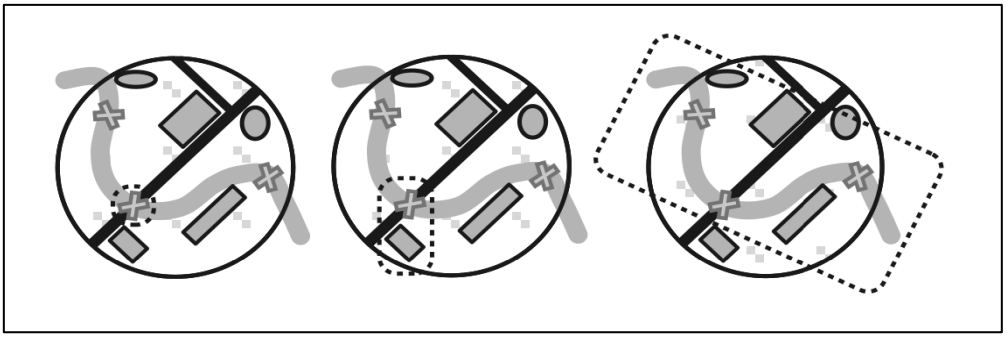

Figure 1. Three approaches to renewal of infrastructure (Willems, 2018)

Hijdra (2017) studied how *value management* can be used for the redevelopment of the Dutch waterways when searching for extra societal value when renewing transport infrastructure. Value management has recently emerged from the public administration literature and is finding its way in planning. Value is herein defined as the sum of all interests and the extent to which these are served ('pareto-efficiency'). An important process in this is the *brokering of interests*. This brokering aims to find maximum value out of all possibilities, as opposed to the usual linear process in which value is pragmatically defined as one solution for a specifically defined problem. Interests are often different and conflicting. This requires smart planning processes in which the search for mutual benefits for the various public and private parties is the key (see also Leendertse 2015).

However, in reality infrastructure planning is still strongly budget-driven and environmental and areal challenges are only linked if this is opportune from the point of view of project control and risk management (Arts et al., 2016; 2021). Infrastructure planning is at its best area oriented, but there is generally no question of integrated area planning (see Heeres, 2017). According to Willems (2018), "the functional scale remains rather sectoral and mono-functional. Although a more integrative perspective is advocated, individual interests prevail over societal benefits.".

In his study, looking for typical patterns in infrastructure decision-making in relation to adjacent area development, Veenma (2021) recognized a constant shift between giving more space to area development - in particular to create support for decision-making – and systematically limiting uncertainty by strongly regulating that space in order to be able to make targeted decisions (*certainification*). From studied cases, he recognized that infrastructure decision-makers only proceed with area development if they are 'forced' to do so. Also, participation takes place within strict frameworks and is mainly aimed at 'reaching consensus' and less on 'mapping out diversity'. He concludes that one-sided and too quick reduction of uncertainty may (or will) lead to polarization and difficult decision-making, exactly the opposite of what is often intended. In his recommendations, he pleas for giving (more) room in infrastructure planning to uncertainty – i.e., to the wishes and ideas of stakeholders and to related challenges in an area (*decertainification*).

## A trend to inclusive infrastructure planning

Yet there is an increasing interest in function mixing and function combination aimed at synergistic benefit (Heeres, 2017). Transport infrastructure networks, such as road, rail and waterway networks, cannot be separated from the area they make accessible or the areas they connect. Areas in turn need infrastructure to function (Arts, 2007; Arts et al., 2016; Heeres et al., 2016; Leendertse, 2020; Arts et al., 2021).

Ever since Mitchell and Rapkin's (1954) provided evidence that transport demand is a function of land use, the interrelation between land use and transport has received much attention by scholars and practitioners, developing the notion of land use and transport integration (LUTI, see Van Geet, 2021). In LUTI the 'I' may stand for integration or interaction. Whereas the latter is focussing the *functional interactions* between land use and transport, the former is focussing on ways in which the dialectic relationship between transport and land-use can be used in the pursuit of synergies and how *integrated planning* of land use and transport can serve broader societal objectives. This paper mainly focusses on this latter interpretation of LUTI.

In planning the contextual factors are becoming increasingly important. The number of actors involved is increasing and becoming more assertive and the interaction between these actors is increasing, making conflicting interests and the importance of regional challenges increasingly visible. The planning of transport infrastructure in relation to the adjacent area is thus shifting from sectoral and separate (mitigation), via participatory (fitting in) to integrated, in which the area challenges are central (Hamersma, 2017; Heeres, 2017). As a result, infrastructure planning and spatial planning are increasingly converging (Heeres et al. 2012; Arts, 2007).

Radulescu (2022) proposes *living labs as a worthwhile creative and collaborative planning approach (co-creation)* for this conversion. Co-creation brings stakeholders and challenges together in a process of 'brokering interests' through dialogue (see also Hijdra, 2017; Heeres, 2017). Co-creation fosters cooperation, interactions, coordination and innovation and involves a diversity of viewpoints. By linking local, regional and national actors, issues and goals it enables integration. However, being relatively new in spatial and infrastructure planning, co-creation is often not part of the formal planning and decision-making processes. Her study now focusses on the positioning of living labs and co-creation in the multi-level governance setting of infrastructure planning. As the further examples in this paper show, living labs and co-creation are

promising tools to develop inclusive solutions (see also Leendertse et al., 2022). But there is no co-creation without space to be able to be creative (Leendertse et al., 2016).

The lack of physical and institutional space (Spijkerboer, 2022) is a decisive factor in the trend to this inclusive planning. Within the sectors of transport infrastructure and area development the physical space for (new) development is decreasing. After all, the physical space has already largely been filled in and infrastructure networks have largely been constructed. In addition, institutional frameworks and preconditions play an increasingly prominent role in infrastructure planning and area development. On the one hand, policy and practice are looking for a foothold in the great dynamics, while on the other, projects are increasingly fixed in rules regarding the environment, process, market involvement, and so on. Willems (2018) argues that *institutional barriers* hinder change because of institutional fragmentation and the dominance of the infrastructure manager. Furthermore, the infrastructure manager currently obstructs more inclusive approaches, because it favors a more mono-functional perspective on renewing assets. Finally, the measures already taken by the operator seem to suffice and are limitedly challenged by others, which also diminishes the need for more radical change. Willems speaks of *institutional sedimentation* i.e., new institutions that complement existing institutions rather than succeeding them. Established institutions thus remain dominant. However, he also recognizes *institutional bridges* that enhance change such as actors' ambition to do more than 'just' renewal.

Van Geet (2021) concluded that pursuing an integrated planning of land use and transport infrastructure requires mixes of complementary instruments that are employed at different stages of the policy process. Procedural instruments play a prominent role in establishing processes of land use and transport integration as they can help to overcome the resource interdependencies associated with the development and delivery of integrated goals on land use and transport by steering interaction in policy networks. Based on a study of the Dutch infrastructure policy design he concludes that there is a continuous *incongruency between policy objectives and instruments* to implement the policy. They are in in a continuous process of fitting to each other, thus influencing institutional space (see Van Geet et al., 2019). Spijkerboer (2022) argues that institutional barriers are often the result of complex and nuanced interrelations between formal and informal institutions, both within individual sectors and in guiding the interactions between them. By pursuing *institutional harmonization*, actors can organize institutional space within and among the various institutional frameworks involved to enable spatial integration – institutional space and physical space are dovetailed. Institutional space is herein conceptualized as something that objectively exists among the various institutional frameworks that guide actors, but this space can be perceived and experienced differently. According to Spijkerboer (2022). institutional harmonization can be seen as a key process in organizing institutional space, by limiting the barriers that result from existing formal and informal institutions and creating enabling conditions among various institutional frameworks that guide actors from various sectors.

### Infrastructure as underlying structure for infrastructure and area integration

The word infrastructure is a literal combination of the Latin 'infra', which means under, and "structure." Infrastructure therefore is an underlying structure that facilitates areal functions. Literally an underlying supporting structure (see Figure 2).

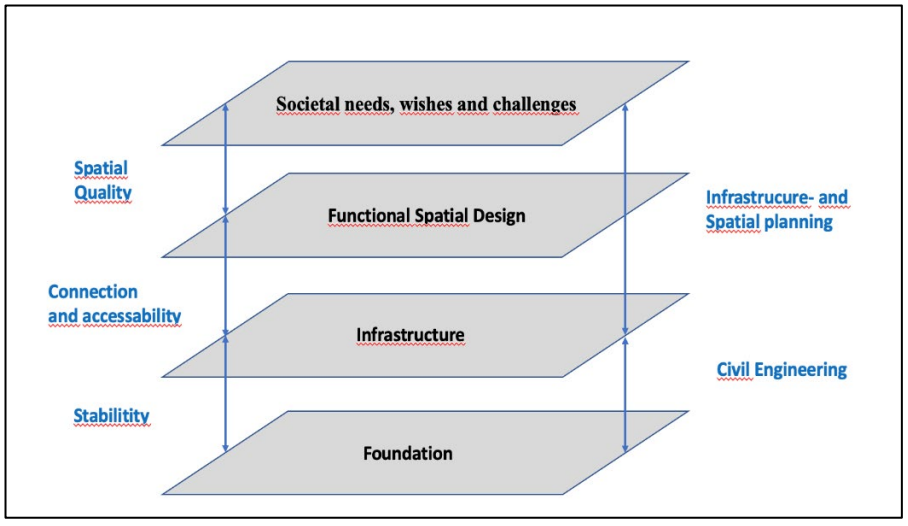


Figure 2. Infrastructure as an underlying structure that facilitates areal functions (multi-layer model)

(Leendertse, 2020)

In areas economic and social functions such as living, working, recreation are performed that create value. This value arises because of the mutual connection of and interaction between these functions through transport infrastructure. Areas also gain value through connection with other areas. Transport infrastructure provides connection and makes areas reachable and as such adds value to an area. A transport infrastructure network in itself has only limited value, but becomes valuable by offering connection and accessibility.

A much-described example of this structuring potential of infrastructure in the Netherlands is the reconstruction of the A2 passage through the city of Maastricht. Verhees (2013) studied this case to look for enablers for integration of infra and area development. In this project, infrastructure and adjacent area development are interwoven in the planning and realization. The development of the plan was outsourced to construction consortia through the contracting of a Design Build Finance and Maintain contract. These consortia had to involve citizens in the planning process and were therefore confronted with arranging the support of the environment for their plans i.e., the responsibility for brokering the interests (see also Heeres, 2017; Hijdra, 2017). Consortia were allowed to use (future) revenues of the area development on adapting the infrastructure (for example, covering the additional costs for a tunnel) in order to arrive at an optimally integrated plan. For the role of the clients (public authorities), Verhees introduced the concept of meta planning as a form of adaptive and conditioning planning aimed at creating conditions that, on the one hand, left sufficient room for the market parties to develop solutions and, on the other hand, provided sufficient direction to fulfil policy goals. In the plan development, the infrastructure directed the area development above and adjacent, but conversely, the area development acted as an enabler for the development of that infrastructure. Due to *a competition effect, a conditioning government and the financial reciprocity of infrastructure and area planning*, infrastructure and area development are linked, which ultimately led to a better solution (see Figure 3).

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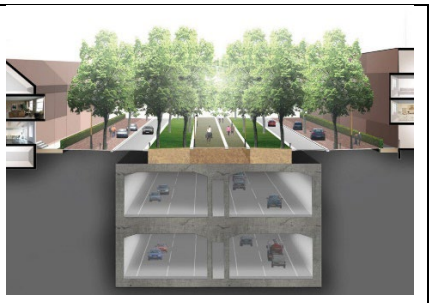
|  |  |  |
| Development of housing and park above and adjacent to the infrastructure | Integration of infrastructure and area development | Double Tunnel construction for through traffic |

Figure 3. ‘De Groene Loper’, the final plan for the A2 passage through the city of Maastricht

The huge infrastructure challenges as mentioned earlier offer a great opportunity to use transport infrastructure as a driver for societal transitions such as the energy transition, climate adaptation, the transition to a circular economy, and so on. Instead of just renovating or renewing, infrastructure planners need to look for opportunities for combination, synergy, multiple use of space, etcetera. A planning aimed at regeneration of infrastructure, whereby transport infrastructure is connected to the area in order to add value to area functions and to act as a catalyst for the societal challenges of the area in order to strengthen transitions.

Let us illustrate the potential of such an approach with another case, the Living Lab A58 in the southern part of the Netherlands (Kerkhofs, 2022). The Living Lab A58 is an experimental environment in which the infrastructure manager (in this case Rijkswaterstaat) together with local citizens, market parties and public organizations search for integrated solutions for climate change. Infrastructure must be made climate-adaptive, which means, among other things, that provisions are made to mitigate flooding caused by intensive rainfall. Water is in fact waste for the infrastructure; it must be disposed of quickly. This wastewater is then be treated as peak discharge via the drainage system of the water boards. On the contrary, agriculture (particularly in the south and east of the Netherlands) faces a water shortage in the summer, also partly as a result of climate change. Currently, this water shortage is often compensated by pumping up groundwater. A possible synergy arises if waste water from the infrastructure – after (ecological) cleaning – is used for the drought problem, possibly by using buffers which can be developed as nature areas. The problem of infrastructure drainage resulting in wastewater then becomes the source for agriculture in dry periods. This creates a circular water flow between the infrastructure and agriculture sectors. A side effect is that less groundwater needs to be pumped up, that surface water is drained more regularly and that nature development is facilitated. A win-win-win situation for the infrastructure manager, agriculture, nature organizations and water boards. In this example, infrastructure is used as a driver for synergistic solutions for environmental challenges. In order to function as a driver, *an integrating theme* appears to be all important, such as 'circularity' in this case.

## From renewal and renovation to regeneration

Many societal challenges and transitions are underway. Regional and infrastructure planners are increasingly confronted with this. Because transport infrastructure is literally a supporting structure for areal functions, infrastructure can be utilized as a support for these challenges and transitions. In fact, the huge renewal and renovation challenge infrastructure planning is facing offers an opportunity to strengthen the transitions. Traditional replacement old-for-new is the easiest way to renew and renovate, but does not do justice to the major challenges our areas are facing. Moreover, the renovation and replacement of infrastructure is about assets that are already there and that will remain in place for at least another 50 to 100 years. This means, that area planning and the replacement and renovation challenge of infrastructure as part of infrastructure planning are interconnected in space and cannot be considered in isolation from each other. We therefore argue that the renovation and replacement of infrastructure should be utilized much more widely and that it should be integrated into a joint infrastructure and area planning. But what does that mean in practice?

Planning is a process. Addressing functional interrelatedness between infrastructure and other land uses within a fragmented stakeholder context of institutional interdependency involves a careful process of creating, assessing and exploiting added value ('brokering of interests'). Based on the discussion in this paper we (see also Heeres, 2017) recommend the following:

- Determine – at the beginning of every stage of a planning process – whether and to what extent an area-oriented approach in addition to infrastructure planning is needed and may lead to added value;
- Organize the planning processes as a co-production. The purpose of co-production of area-oriented plans and designs is to find relevant combinations between infrastructures and other land uses;
- To exploit the potential merit of actors' complementarity in the creation of integrated plans and programmes for implementation, it essential that the commitment of actors is not without obligation. The establishment of coalitions may be formalized in covenants or other types of agreements about cooperation between various actors at the infrastructure-land use interface;
- Set up collective business cases to redress the balance between spatial scales. Area-oriented planning focuses on improvements to the land uses at the regional and local area scale. Business cases may help to redress the balance between gains at the networks and gains at the regional and local spatial scale;
- And last but not least, create room for opportunities and facilitate actors to search for win-win synergies by facilitating interaction and dialogue.

By linking renewal and renovation of transport infrastructure assets to the world of area development, replacement becomes more visible and politically more interesting ('sexy'). Investment in infrastructure replacement can then become an incentive to define and co-finance area development and a driver for accelerating societal transitions – a window of opportunity. Then renewal and renovation of infrastructure assets becomes regeneration of infrastructure as part of sustainable re-development of the surrounding area.

**References:**


Arts, J. (2007). *Nieuwe Wegen? Planningsbenaderingen voor duurzame infrastructuur*. Inaugural speech, Groningen: Rijksuniversiteit Groningen

Arts, J., Filarski, R., Jeekel, H. & Toussaint, B. (Ed.) (2016). *Builders and Planners. A History of Land-use and Infrastructure Planning in the Netherlands*. Delft: Eburon.

Arts, J., Leendertse, W & Tillema, T. (2021), Road infrastructure: planning, impact and management, in: Vickerman, R. (ed.), *International Encyclopedia of Transportation*. 5, pp. 360-372. Elsevier, UK.

Hamersma, M. (2017), *Living near Highways – The impact of existing and planned highway infrastructure on residential satisfaction*, PhD thesis, University of Groningen, Groningen.

Heeres, N. (2017). *Toward area-oriented approaches in infrastructure planning: Development of national highway networks in a local spatial context*. Doctoral dissertation. Groningen: University of Groningen

Heeres, N., Tillema, T. & Arts, J. (2016) Dealing with interrelatedness and fragmentation in road infrastructure planning: an analysis of integrated approaches throughout the planning process in the Netherlands. *Planning Theory & Practice*, 17(3): 421-443.

Hijdra, A. (2017). *Waterways – Ways of Value: Planning for redevelopment of an ageing system in modern society*. Doctoral dissertation. Groningen: University of Groningen

Hijdra, A., Woltjer, J. & Arts, J. (2015). Troubled waters: An institutional analysis of ageing Dutch and American waterway infrastructure. *Transport Policy, 42:* 64-74.

I&M (2016) *Integraal Duurzaam Opdrachtgeverschap Vervanging en Renovatie*. The Hague: Ministry of Infrastructure & the Environment.

I&W (2018). *Kamerbrief over Programma vervanging en Renovatie voor bruggen, tunnels, sluizen en wegen*. The Hague: Ministry of Infrastructure & Water Management.

Kerkhofs, S. (2022). *Bouwen met de natuur als partner. Een persoonlijke visie op gebiedsdenken*. In: Naar een circulaire economie, Blauwdruk, Wageningen.

Leendertse, W.L. (2015), *Public Private Interaction in Infrastructure Networks*, PhD-thesis, University of Groningen, Groningen.

Leendertse, W. (2020). *Infrastructuur in beweging. Een perspectief op management in planning van infrastructuur in een dynamische wereld*. Inaugural speech, University of Groningen.

Leendertse, W., de Groot, B. & Busscher, T. (2022). *Balancing hedging and flexing for inclusive project management*. In: Project Management. New Trends and Applications. IntechOpen

Leendertse, W., Verhees, F. & Arts, J. (2016), Publieke en Private Samenwerking als Verbinder van Infrastructuur en Ruimte – Een Verkenning, in: W. Salet (ed.), *Gaan waar de actie is – Ruimtelijke onderzoeksinstituten adviseren over nationale ruimtelijke planning*, InPlanning, Groningen, pp. 160-179.

Radulescu, M. (2022). *Living Labs, a creative and collaborative planning approach*. In: Co-creativity and engaged scholarship, Franklin, A. (ed.), Palgrave MacMillan

Spijkerboer, R. (2022). *Institutional harmonization for energy transition. How actors 'play the game' of balancing renewable energy generation with other sea- and land-uses.* Doctoral dissertation. Groningen: University of Groningen

Van Geet, M. (2021). *Policy Design and Infrastructure Planning. Finding tools to promote land use transport integration*. Doctoral dissertation. Groningen: University of Groningen

Van Geet, M., Lenferink, S., Arts, J., & Leendertse, W. (2019). Understanding the ongoing

struggle for land use and transport integration: institutional incongruence in the Dutch

national planning process. *Transport Policy*, 73 (2019), 84-100.

Veenma, K. (2021). *Ruimte voor onzekerheid. Interactie tussen actoren in de dynamiek van infrastructuurplanning*. Doctoral dissertation. Groningen: University of Groningen.

Verhees, F. (2013). *Public-private Partnerships – Adaptive planning in theory and practice*. Doctoral dissertation. Groningen: University of Groningen

Willems, J. (2018). *Navigating Waterway Renewal – Actor-centred institutional perspectives on the planning of ageing waterways in the Netherlands*. Doctoral dissertation. Groningen: University of Groningen