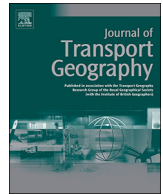




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## A critical review on the evolution and development of inland port research

Patrick Witte<sup>a,\*</sup>, Bart Wiegmans<sup>b,c</sup>, Adolf K.Y. Ng<sup>c,d</sup><sup>a</sup> Department of Human Geography and Planning, Faculty of Geosciences, Utrecht University, The Netherlands.<sup>b</sup> Department of Transport and Planning, Faculty of Civil Engineering, TU Delft, The Netherlands<sup>c</sup> Transport Institute, University of Manitoba, Canada<sup>d</sup> Department of Supply Chain Management, Asper School of Business, University of Manitoba, Canada

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## ABSTRACT

Over the past twenty-five years a considerable amount of literature has emerged that addresses inland port development in a variety of ways and in different institutional contexts. A recurring issue throughout most papers focusing on inland ports is the wide diversity of definitions, actors, functions, levels and geographies that are of relevance. Therefore, a literature review on inland port development contributes to defining the most important streams in inland port research. Recent studies show that the concept of inland ports is clearly much richer and more diversified than merely an extension of deep-sea ports or port logistics. However, as much of the literature is still largely based on individual case studies and anecdotal evidences, the conceptualization of inland ports has proven to be particularly difficult. Therefore, this review paper presents a systematic and integrated review of inland port studies, covering 80 international peer-reviewed academic journal papers on inland port development between 1992 and 2017. The results show that much attention is paid on inland ports as components of the ‘transport/logistics/supply chain’ systems (follower), while their roles as components of the ‘regional’ systems (leader) are largely overlooked. Such a tweaked focus is likely to pose significant impacts on planning, management, and governance of inland ports.

## 1. Introduction

Over the past twenty-five years a considerable amount of literature has emerged that addresses inland port development in a variety of ways and in different geographical and institutional contexts. For instance, Ng et al. (2014) have considered the development of inland port facilities as a distinctive dimension in port geography, viewing it mostly (but not always) as an extension of port studies. Wiegmans et al. (2015) have discussed the diverging definitions of inland ports in North-America and Europe respectively. And Witte et al. (2017) have addressed the multi-level nature of inland ports and presented four analytical dimensions for studying inland ports, paying attention to infrastructure, spatial structure, governance structure and economic structure. A recurring issue throughout most papers focusing on inland ports is the wide diversity of definitions, actors, functions, levels and geographies that are of relevance. Therefore, a literature review on inland port development contributes to defining the most important streams in inland port research.

For a long time, inland ports were mainly studied from an operational and planning perspective (e.g. Monios and Wilmsmeier, 2012), but in recent years we see attention shifting to governance and

management of inland ports, as well as their spatial and economic impacts to surrounding regions. Also, because of the different definitions involved, the literature on inland ports is rather scattered, referring to among others inland terminals (e.g. Rodrigue and Notteboom, 2009), dry ports (Roso et al., 2009) or freight villages (e.g. Tsamboulas and Kapros, 2003), to name but a few. Moreover, geographical differences (e.g. North-American vs. European inland ports) and the variety of actors involved in inland port development (Rodrigue et al., 2010) are blurring our understanding of this object of study.

This is not to say that no attempts have been made to conceptualize the evolution and development of inland ports, with Notteboom and Rodrigue (2005) and Rodrigue and Notteboom (2009)’s port regionalization and terminalization of supply chains, respectively, being notable examples. However, as per latter research on inland ports, especially those that focused on developing countries (e.g. Ng and Gujar, 2009a, b; Padilha and Ng, 2012), the concept of inland ports is clearly much richer and more diversified than merely an extension of seaports or port logistics. However, as much of the literature is still largely based on individual case studies, the conceptualization of inland ports is particularly difficult.

Hence, it is very important to conceptualize the evolution and

\* Corresponding author.

E-mail address: [p.a.witte@uu.nl](mailto:p.a.witte@uu.nl) (P. Witte).<https://doi.org/10.1016/j.jtrangeo.2018.11.001>

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development of inland ports in a more systematic way, as the lack of such a systematic approach implies that it would be much more difficult for planners and policymakers, both in terms of inland port management and public administration, to learn the pros and cons from any past lessons and effectively apply them into future planning, management, and governance. Therefore, this review paper presents a systematic and integrated review of inland port studies, covering most of the international peer-reviewed academic journal papers on inland port development between 1992 and 2017. We aim to structure the empirical insights concerning inland ports through different time periods, in different geographical settings and by different analytical dimensions of inland ports. Based on this overview, the goal is to define gaps in the literature, and to create an agenda for further research. While acknowledging the variety of terminology found in the literature, we choose to use the following working definition of inland ports, which in our view captures the broad understanding scholars have regarding this concept when referring either to inland ports or to dry ports: “an inland facility with or without an intermodal terminal and logistics companies, which is directly connected to seaport(s) with high capacity transport mean(s) either via rail, road or inland waterways, where customers can leave/pick up their standardized units as if directly to a seaport” (based on Roso et al., 2009 and Wiegmans et al., 2015).

The remainder of this paper is structured as follows. In the next section, the methodological approach towards the literature review is explained, followed by descriptive statistics from our analysis of the literature. Next, we review the literature according to different time periods: early stage up to and including port regionalization (1992–2005); diversification (2006–2011) and contextualization (2012–2017). Finally, the discussion and conclusion section highlights how our findings contribute to a better understanding of the evolution of inland ports and an identification of research gaps that inspires the research agenda for future inland port studies.

## 2. Methodological approach

In this paper, we aim to structure the empirical insights concerning inland ports through different time periods, geographical settings and analytical dimensions. For this purpose, we have adopted a systematic literature review. Different types of review papers exist (van Wee and Banister, 2016). Our primary goals are to define research gaps in the literature, and to create an agenda for further research. Our review consists of the following steps. First, for the planning and execution of the review, we defined different selection criteria for inclusion or exclusion of papers in this review. Second, we conducted a systematic search of the scientific literature based on the criteria. Third, we analyzed the papers and retrieved the relevant information for the review. Finally, data analysis and synthesis were performed. The details of the data analysis and synthesis is presented in the remainder of the paper; here we discuss in more detail our methodological approach.

We selected 1992 as the starting point of our review. The reasons for choosing this year are first of all that this can roughly be considered as the start of the contemporary world after the Cold War. In this year, the Maastricht Treaty was also signed, resulting in an opening up of the European continental hinterland. Moreover, after 1992, a period of rising privatization and port restructuring started and, finally, in this period academic attention to globalization and supply chain management sharply increased. Based on this, we selected scientific journal papers over the timespan of the past 25 years (1992–2017). We selected a list of scientific journals based on three disciplines: transportation, logistics and geography. This resulted in a list of 34 key journals (Appendix A). They are all scientific journals, with publications written in English. Other sources such as: (refereed) conference publications, books and book chapters, doctoral dissertations and other ‘grey’ literature such as official publications and/or websites of scientific groups, international organizations or companies are not considered in this literature review. The reason for this is the greater difficulty in

systematically collecting and categorizing the relevant contributions and objectively assessing the quality of the respective contributions is almost impossible. We assembled a list of key words which were used to search in abstract, title and key words of the well-established academic search engine Scopus ([www.scopus.com](http://www.scopus.com)). The list of key words includes: inland port; inland terminal; dry port; intermodal [freight] terminal; transport hub; logistics hub; transport node; hinterland and freight village.

Based on these selection criteria, we collected a gross list of 138 papers which seemed relevant based on an initial screening of the title, abstract and key words. We used a broad view on inland port development, and included aspects such as location, governance, management, operations, institutions, etc. To narrow down the gross list, we read and assessed the abstract, introduction and conclusion for relevance. The main consideration to include or exclude a paper was the question of how important the inland port concept was to the central argument or focus of that particular paper. In doing so, particularly papers focusing on regional port-, container- or terminal systems and -clusters, and hinterland competition and -optimization studies were excluded, because these papers paid no specific attention to the characteristics of inland ports, leaving but very little suitable material for the purposes of our analysis. After data cleaning, a total list of 80 papers remained and was included in the reviewing procedure. These papers were analyzed in detail and the relevant information was collected in a data extraction form. This summary sheet included basic information of the publications (title, authors, journal, publication details), as well as other more detailed features of this review study.

## 3. Descriptive analysis on results of the review

To analyze the results of the review, we first break-down the analysis of the 80 full papers into several descriptive characteristics. We pay attention to: 1) papers published across journals over time, 2) papers by geographical focus over time, 3) papers by type of methodology over time, 4) papers by type of definition over time, 5) key authors and network collaborations and 6) key themes and conceptual approaches over time.

### 3.1. Papers published across journals over time

First, when looking at papers across journals over time, the following picture emerges (Fig. 1).

Up to 2000, little attention is paid to inland ports (3 publications). Leading towards 2005 and the port regionalization publication by Notteboom and Rodrigue (2005), the number of papers is increasing to 9 publications cumulatively. This trend is ongoing in the 2006–2011 period with 24 additional publications, but the sharpest increase is observed in the 2012–2017 period with 47 extra publications. This increase is partly explained by a few special issues in this period, which aggregates a number of papers in a particular year, but also by a number of contextualized case studies in key journals (notably, *Journal of Transport Geography*).

Looking at the journals (Appendix B), the main debate on inland ports has been ongoing in the *Journal of Transport Geography* since Slack's publication on satellite terminals (1999). This journal has captured the bulk of papers (20 in total), with especially in recent years a steady increase in the number of publications dealing with inland ports. However, there is a range of journals in the broader fields of transportation and geography that have paid recurring attention to inland ports as well. Other significant hosts for inland port studies include *Maritime Policy & Management*, *Maritime Economics & Logistics*, *World Review of Intermodal Transportation Research*, *Research in Transportation Economics* and *Research in Transportation Business & Management*. Especially *Research in Transportation Business & Management* appears to be an upcoming journal. This might be partly related to the thematic orientation of this journal, in which guest editors often work on a few

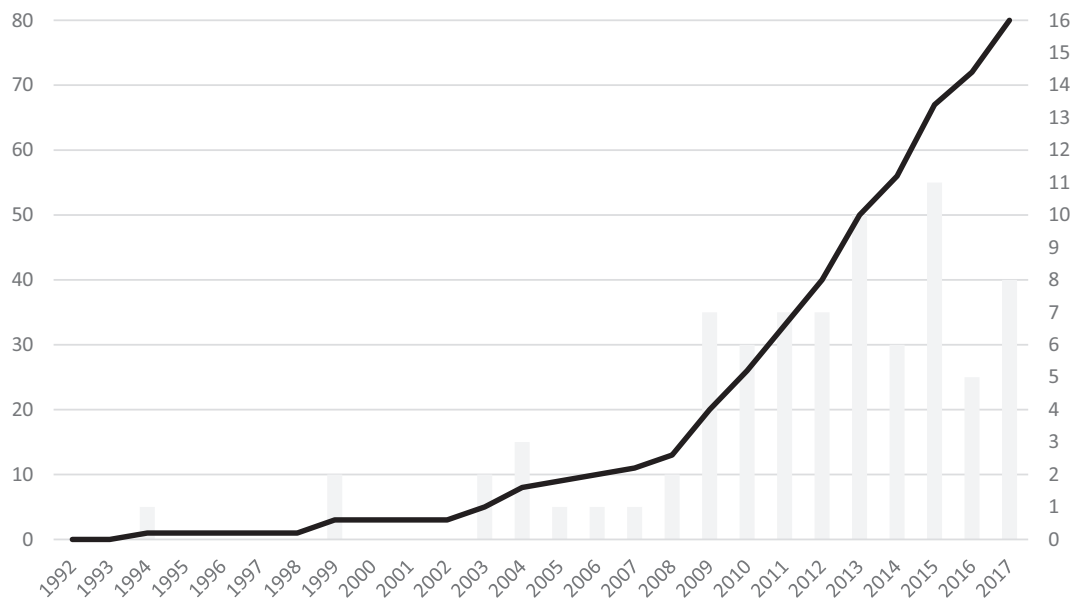


Fig. 1. Number of publications per time period (1992–2017).

issues around a particular theme, resulting in an agglomeration of papers in a particular time period.

### 3.2. Geographical focus over time

Second, we can break the results down by looking at geographical focus over time (Table 1).

An important observation here is that alongside the absolute increase in numbers of papers over time, we see a diversification of geographical focus. Up to 2011, we observe that conceptual studies and studies with a dominant Europe or North-America focus and/or comparison are commonplace. After 2011, the geographical focus broadens to other contexts, with a notable growth and diversification within Europe (North-west, Northern/Baltic, Mediterranean) but also a convincing worldwide coverage (Latin America, Asia, Pacific). Remarkably, African countries remain understudied.

### 3.3. Differentiation by type of methodology

Third, we can differentiate the review papers by type of methodology being used (Table 2).

We can confirm here what was mentioned before regarding the predominance of case study research and anecdotal evidence regarding inland ports. The majority of contributions has a dominant case study

Table 1  
geographical focus of papers over time (1992–2017).

Geographical focus	1992–2005	2006–2011	2012–2017	Total
Unknown/conceptual	2	5	8	15
North-west Europe <sup>a</sup>	1	1	12	14
Asia	–	4	9	13
General Europe	2	2	3	7
Europe/North-America comparison	–	4	2	6
North-America	4	1	1	6
Northern Europe/Baltic	–	3	3	6
Mediterranean Europe	–	2	3	5
Latin America	–	–	4	4
Pacific (Australia)	–	1	2	3
Africa	–	1	–	1
<b>Total</b>	<b>9</b>	<b>24</b>	<b>47</b>	<b>80</b>

<sup>a</sup> Including the United Kingdom.

Table 2  
differentiation of papers by type of methodology (1992–2017).

Type of study	1992–2005	2006–2011	2012–2017	Total
Case study	1.5	10.5	22.5	34.5
Conceptual study	3.5	7.5	7.5	18.5
Quantitative (modeling)	3	2	10	15
Quantitative (empirical)	1	2	2	5
Literature review	0	1	4	5
Editorial	0	1	1	2
<b>Total</b>	<b>9</b>	<b>24</b>	<b>47</b>	<b>80</b>

Note: papers that use two methods (e.g. conceptual + case study) have been counted as halves, e.g. attributing 0.5 to conceptual and 0.5 to case study.

focus or combines a conceptual study with some case study evidence ( $n = 34.5$ ). Next to this, we see a fair number of publications without any significant empirical foundation, either being fully conceptual studies ( $n = 18.5$ ) or modeling studies ( $n = 15$ ). The number of quantitative empirical studies is low with 5 publications. The distribution of papers over the various types of methodology shows little variance over time, but we observe a general unbalanced attention favoring many conceptual and/or case study-based contributions over few empirical studies.

Regarding the few literature studies that so far have been carried out, we have the modest impression that this paper takes the most comprehensive approach to understanding how the inland port debate has evolved over time. For instance, [Roso and Lumsden \(2010\)](#) limit their scope to reviewing the dry port literature and [Caris et al. \(2014\)](#) narrow their view to inland waterway transport, whereas in the case of [Notteboom et al. \(2013\)](#) inland ports are but a minor aspect of their entire analysis on forty years of maritime port studies. In [Notteboom et al. \(2017\)](#) the term ‘inland port’ seems to be disregarded altogether in favor of ‘logistics center’ as umbrella concept.

### 3.4. Definitions used over time

Fourth, we can look into the type of definition being used over time (Table 3), looking at the main terminologies that are used by authors throughout the study period.

Starting from ‘freight villages’ ([Tsamboulas and Dimitropoulos, 1999](#)), the concept was mainly introduced in the early 2000s, with researchers like [Walter and Poist \(2003, 2004\)](#), [Rodrigue and/or](#)

**Table 3**  
terminologies used by authors throughout the study period (1992–2017).

Terminology	1992–2005	2006–2011	2012–2017	Total
Dry Port	0	9	13.5	22.5
Inland terminal	2	7.5	4.5	14
Inland Port	2	3.5	11	16.5
Inland Transport/Logistics Hub	1	1	1	3
Freight Village	2	0	2	4
Intermodal Terminal/Logistics Platform	0	1	5	6
Thruport	0	1	0	1
<b>Total</b>	<b>7</b>	<b>23</b>	<b>35</b>	<b>57</b>

Note: terms that have been used simultaneously are counted as ‘0.5’ which is the case for [Notteboom \(2010\)](#) and [Santos and Soares \(2017\)](#).

Notteboom termed them as ‘inland terminals’ or ‘inland ports’. The term ‘dry port’ did not come into place until the 2006–2011 period with researchers such as Ng and Roso actively promoting the term through their consecutive publications (e.g. [Ng and Gujar, 2009a, b](#); [Ng and Tongzon, 2010](#); [Roso, 2007, 2008](#); [Roso et al., 2009](#); [Roso and Lumsden, 2010](#)). During the same period, several alternative terms were introduced (although they never really took off), such as ‘inland transport/logistics hub’. In the second decade of the 21st century, the terms ‘intermodal terminals’ and ‘logistics platforms’ were proposed as a way to highlight the intermodal nature of transportation and its (important) roles in logistics and supply chains. Nevertheless, the general academic community has seemed to fully adopt ‘dry ports’ and ‘inland terminals/ports’ for research purposes.

A point of interest is that ‘inland terminals/ports’ have been nearly exclusively used for research that focuses on North-America, North-west Europe and/or Mediterranean Europe. Among the 30.5 papers that use ‘inland terminals/ports’, the only exceptions are [Wood \(2006\)](#), [Monios and Wang \(2013\)](#) and [Wilmsmeier et al. \(2015\)](#), which focus on Africa, Asia, and Latin America, respectively. On the contrary, the use of ‘dry ports’ is much more popular among works that focus on Asia, Russia/Baltic Europe and Latin America. Among the 22.5 papers that use ‘dry ports’ (note that 5 papers using ‘dry ports’ have no specific geographical focus), only 2 of them focus on North-America, North-west Europe and/or Mediterranean Europe. It seems that some kind of split exists between ‘the west’ and ‘the rest of the world’.

### 3.5. Key authors and network collaborations

Fifth, the use of terminologies largely depends on the key authors ([Table 4](#)). The key authors that use ‘inland terminals/ports’ include [Rodrigue](#), [Notteboom](#), [Monios](#), [Wilmsmeier](#), [Witte](#) and [Wiegman](#)s, while the key authors that use ‘dry ports’ include [Roso](#), [Ng](#), [Lumsden](#), [Henttu](#), and [Hilmola](#). ‘Defection’ of terminologies is rather rare. In this regard, there are two cases where the key author(s) have ‘defected’ from ‘inland terminals/ports’ to ‘dry ports’ ([Wilmsmeier and Monios](#),

**Table 4**  
key authors and main network collaborations.

Key author	Publications	Top co-author <sup>a</sup>
<a href="#">Notteboom, T.</a>	13	<a href="#">Rodrigue, J.P.</a> (6)
<a href="#">Monios, J.</a>	12	<a href="#">Wilmsmeier, G.</a> (7)
<a href="#">Rodrigue, J.P.</a>	12	<a href="#">Notteboom, T.</a> (6)
<a href="#">Roso, V.</a>	8	<a href="#">Lumsden, K.</a> (2)
<a href="#">Wilmsmeier, G.</a>	8	<a href="#">Monios, J.</a> (7)
<a href="#">Ng, A.K.Y.</a>	6	<a href="#">Gujar, G.C.</a> (2)
<a href="#">Wiegman, B.</a>	6	<a href="#">Witte, P.</a> (4)
<a href="#">Langen, P. de</a>	4	<a href="#">Berg, R. van den</a> (2)
<a href="#">Witte, P.</a>	4	<a href="#">Wiegman, B.</a> (4)
<a href="#">Bergqvist, R.</a>	3	<a href="#">Monios, J.</a> (1)
<a href="#">Hilmola, O.P.</a>	3	<a href="#">Henttu, V.</a> (2)

<sup>a</sup> Number of shared publications with top co-author in brackets.

[2016](#); [Rodrigue and Notteboom, 2012](#)), while Ng has used ‘inland ports’ once ([Ng et al., 2015](#)). Hence, it seems that the use of terminologies depends a lot on the style and preference of the key authors.

The rare defection of terminologies is also visible in the main network collaborations ([Table 4](#)), which shows that authors who share the same terminology also often work together. This table also clearly shows that the inland ports debate is dominated by 10–15 key authors who write regularly on this topics. Besides this, there are 80–90 authors who published on this topic just once or twice.

### 3.6. Key themes and conceptual approaches over time

Sixth and finally, we want to assess how the previous differences (i.e. in time period, journal type, geography, methodology, definitions and authors) is shaping the key themes and conceptual approaches that are visible over time. We observe three major time periods: early stage up to and including the port regionalization paper ([Notteboom and Rodrigue, 2005](#)) (1992–2005), diversification stage up to and including the first directional development paper ([Wilmsmeier et al., 2011](#)) (2006–2011) and contextualization stage up to and including 2017 (2012–2017).

In the first period, 1992–2005, research mainly investigates: 1) if an inland port is needed and 2) if needed, how to construct it and how different methods would affect the inland port as an infrastructural setting, and 3) some initial discussions about the linkage between inland ports and other components of the logistical/supply chains. Key words in this period include freight village, construction, appraisal, viability and feasibility.

The second period (2006–2011) is a period where research puts much more emphasis on 1) how the development of maritime logistics led to the development/need for inland ports, and the linkage and importance of inland ports on logistics and supply chains, 2) introduces (conceptually) what an inland port is, 3) the attempt (and competition between authors) to build theories on the characteristics of inland ports (e.g. ‘outside-in vs. inside-out’, the locational characteristics of inland ports) and, 4) how the operation and governance of inland ports should be implemented. Most of the discussions are rather ‘macro’, that aim to occupy a significant impact in the theoretical discussions of inland port development. During this period, even for studies that have case studies, there is a strong tendency to link the lessons from the case to a macro perspective. The focus during this period is about the operation of the ‘logistical system’ rather than the impacts (externalities) of inland ports. Key words for this period include dry port, inland terminal, inland port, supply chain, logistical system, locational characteristics, port regionalization, implementation, operation, outside-in, inside-out.

In the third period (2012–2017), after the first ‘academic battles’ (e.g. theorizing on inland port development), the research focuses on 1) ‘sectoral’ issues that can affect the efficient governance of inland ports (e.g. relationship with port authorities, impacts of institutions on inland port governance), 2) ‘global’ issues that can impact on the operation and governance of dry ports (e.g. green portfolios), 3) impact-related topics, i.e., inland ports and the surrounding urban/regional environments (e.g. inland port-city relationships, inland ports and regional economic growth, inland ports as a challenge for planning and metropolitan governance), 4) more ‘micro’ perspectives, that is, more geographically focused, especially on the emerging economies (e.g. India, Russia, China) and/or regions that are ‘not as central’ in the global market (e.g. Portugal, Australia, Malaysia). Key words for this period include institutions, green portfolio, impact, planning, regional growth, inland port-city relationship, emerging economies, developing countries.

Through the different time periods, we identify four main conceptual approaches ([Fig. 2](#)). In this, we see that each subsequent approach is building on the foundations of its predecessor and that over time, the ‘older’ approaches seem to lose interest relative to the ‘newer’ ones. The period up to 2005 is dominated by papers using a

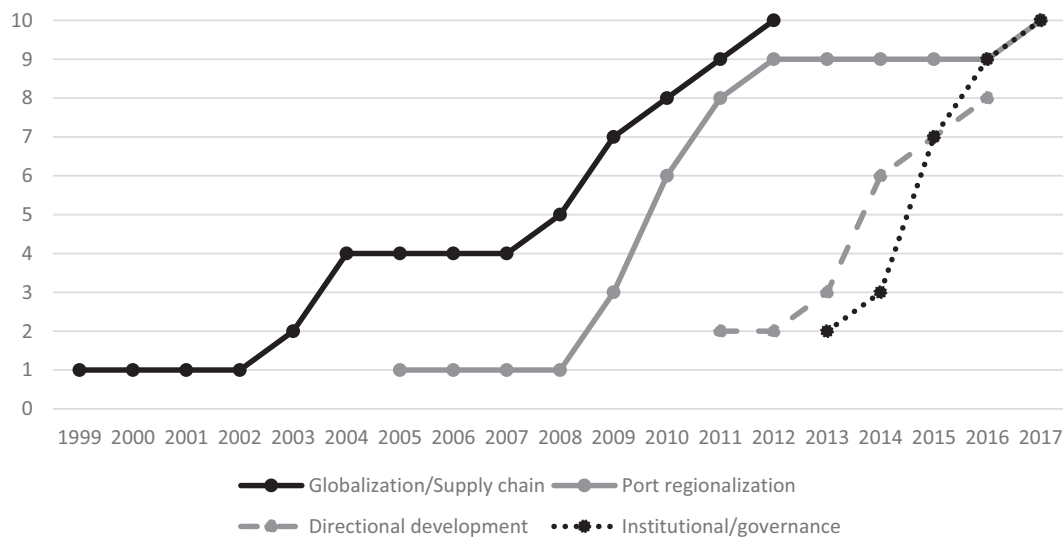


Fig. 2. Key conceptual approaches over time (1999–2017).

globalization/supply chain management perspective. This culminates into the port regionalization paper of Notteboom and Rodrigue in 2005, which is attracting considerable interest in the following years. This period of diversification of the port regionalization concept is finalized by the directional development idea of Wilmsmeier and Monios. Their inside-out/outside-in perspective dominates the discussion in the years after 2011. In this period, however, attention to the contextualization of inland port development is also growing, which is reflected in a growing interest in institutional and/or governance approaches in the most recent years.

#### 4. Inland ports: from supply chain component to stand-alone research area?

Ever since the publication of Slack (1999), who first introduced the idea of satellite terminals as a local solution to hub congestion, attention to what we refer to as ‘inland ports’ has been growing. A commonality running over the entire period of observation is that even after nearly twenty-five years, a uniform definition of inland ports is still missing. We observe that in many articles – especially in the early years since Slack’s publication and running roughly until Notteboom and Rodrigue’s (2005) paper on port regionalization – inland ports are not the central unit of study in the analyses of the papers. In many publications, maritime ports or terminals are at the center of attention, and inland ports are reflected upon mainly as part of the wider supply chains and transport networks, or as a dedicated case study area to illustrate a specific aspect or phenomenon of hinterland strategies of maritime ports.

With the publication of the first article on port regionalization (i.e. Notteboom and Rodrigue, 2005), we observe that in the years following this article there is a rise of publications in which the (role of the) inland port is more central. This is especially reflected in the publication of Wilmsmeier et al. (2011) who draw attention to the directional development of inland ports (Outside-In vs. Inside-Out). Yet, we still have to conclude that the emphasis on Outside-In driven development (ranging from the seaports towards the inland ports) remains, also in the years after 2011. After that, we mainly see a diversification of interpretations of inland port development, in which the attention to the spatial and institutional dimension of inland ports is becoming more prominent. In this, geographical context – and hence context-sensitive governance approaches – is also growing in importance.

In the remainder of this section we will discuss our findings in more detail. First, we dive in the early stages of inland port development and

discuss how inland ports via the port regionalization concept became embedded in the wider debates on port system evolution. Next, we explain how this debate has diverged over the years, in which attempts have been made to understand this. After that, we delve into our main point, which is that inland ports have mainly been studied as undervalued components of the ‘transport/logistics/supply chain’ systems (follower), while their roles as important components of the ‘regional’ systems (leader) are largely overlooked. This may have resulted in a limited and one-sided continental and/or operational understanding of inland ports, whereas there is also much to be learned from how inland ports might influence spatial and institutional transformations and have economic impacts on the local to regional scale. Therefore, we draw attention to the spatial, institutional and economic dimensions of inland ports (especially reflected in the Outside-In vs. Inside-Out discussion) and argue for the importance of a context-sensitive understanding of inland ports, and the implications this has for governing them. We finalize our analysis by pointing out gaps and future research directions.

##### 4.1. Early stage (1992–2005): from port congestion to port regionalization

In this first period, the number of papers is relatively limited and the inland ports are not very central in the papers concerned. Two important trends in the evolution of port systems can be identified in this period: de-concentration of seaport traffic and decentralization (inclusion of inland port governance into seaports) of port governance. The increasing volumes in seaports brought about ‘overloaded seaports resulting in the de-concentration of port traffic and the development of dry ports’ (Wilmsmeier et al., 2015). Congestion at seaport terminals led to a move towards the extended gate concept to relieve the container terminals in the ports and to replace seaport functions towards inland ports and terminals (Rodrigue and Notteboom, 2009).

The growing interest in inland ports originating from this point of view is also reflected in the initial focus of the research so far on Outside-In driven port development (cf. Wilmsmeier et al., 2011). Initially, the inland ports are not very central in the research but the focus is more on networks, supply chains and seaports. In port governance, short term gains in efficiency in individual ports contrast with a long term loss of power from the public to the private sector and the lack of integrated transport and logistics policies necessary to support ongoing port development (Wilmsmeier and Monios, 2016). An exemplifying paper in this respect is by Tsamboulas and Dimitropoulos (1999): the goal is to identify the underlying factors that influence the choice of an appraisal method. In this paper, it is found that the choice of appraisal

method and the decision criteria for the investment are linked primarily to the nodal center's size, catchment area, and the support or absence of political approval for the investment.

Other characteristics of this time period are that the main geographical focus is limited to North-America or Europe, and that the nature of the contributions is mainly conceptual. Examples of North-America focused papers are [Walter and Poist \(2003, 2004\)](#), who mainly put the differences in preferences and perceptions of port stakeholders (i.e. shippers, carriers, etc.) central and [Rodrigue \(2004\)](#) who defines inland ports as regional articulation points as part of wider supply chains. In the European context, the focus is mainly on freight villages ([Tsamboulas and Dimitropoulos, 1999](#); [Tsamboulas and Kapros, 2003](#)). This period is concluded by the influential paper on port regionalization ([Notteboom and Rodrigue, 2005](#)). This paper has been cited 458 times (as of September 2018, according to Scopus) and can be seen as agenda-setting for many inland port papers. It offers a plea for governance to avoid the oversupply of inland facilities, in particular on the European mainland.

In sum, this period can be characterized by de-concentration of port traffic and decentralization of port governance. A main feature of this period is that the inland port is not (yet) central to the analysis, but the focus is mainly on establishing the hinterland as a distinctive dimension of port system development.

#### 4.2. Diversification stage (2006-2011): beyond port regionalization

This period can be characterized by diversification of the subject, which means that different research tracks are developed and the scope of inland port research in general broadens. A particular research track that is rising up in this period relates to dry port development ([Roso, 2007, 2008](#); [Roso et al., 2009](#)), which mainly evaluates the usefulness of the dry port concept by looking at environmental aspects such as emission reduction, congestion reduction and waiting time reductions at the terminal, looking at implementation factors of dry ports such as direct rail connections and looking at the connection of dry ports with seaport systems. In the American context, this is also known as the 'Thruport' system by [Rodrigue \(2008\)](#).

Within this time period, we observe that many papers lean theoretically and conceptually on the regionalization concept as per [Notteboom and Rodrigue \(2009\)](#). This is reflected for instance in attention to containerization ([Notteboom and Rodrigue, 2009](#); [Notteboom, 2010](#)), in which inland ports are positioned in seaport networks via corridors, and attention to the terminalization of supply chains ([Rodrigue and Notteboom, 2009](#)), in which inland ports (i.e. inland terminals) are viewed as extended gates. Overall, the inland port is not (yet) central to the analysis, with the notable exception of [Rodrigue et al. \(2010\)](#), who outline a first taxonomy of inland ports. They acknowledge the conceptual confusion in labelling (e.g. dry ports, inland terminals, satellite terminals, load centers, transmodal centers) and they stress the variety of geographical settings, functions and actors. The geographical focus in this period grows and now also includes Asia (e.g. [Ng and Gujar, 2009a, b](#)), the Pacific (e.g. [Roso, 2008](#)) and Africa (e.g. [Wood, 2006](#)), and first overview papers analyzing concepts and types of inland ports are introduced (e.g. [Roso and Lumsden, 2010](#)). This period is finalized by the publication of [Wilmsmeier et al. \(2011\)](#) on the directional development of inland ports.

#### 4.3. Contextualization stage (2012-2017): directional development of inland ports

This period can be characterized by the development of two main streams: Outside-In and Inside-Out driven inland port development, following the paper by [Wilmsmeier et al. \(2011\)](#). In this, the Outside-In approach remains focused on operational aspects of inland port development from a dominant supply chain focused perspective (e.g. [Veenstra et al., 2012](#); [Wilmsmeier et al., 2015](#)). In contrast, especially in

the Inside-Out approach (see [Monios and Wilmsmeier, 2012, 2013](#)) we also observe a quickly developing diversification of subjects, also paying increased attention to the spatial and institutional dimensions of inland ports (e.g. [Witte et al., 2014](#); [Wiegmans et al., 2015](#); [Raimbault et al., 2015](#)). The Inside-Out focus from the point of view of the inland port is all the more important as inland port development does not only have advantages but also disadvantages such as congestion, emissions, nuisance, etc. in seaports that are exported inland. In this respect, there seems to be developing a trend to look at actor-relational aspects of inland ports (e.g. inland port-city challenges). This is nuancing the supply chain focused perspective on inland ports and puts more emphasis on the position of inland ports as leader in regional systems.

Parallel to the Outside-In, Inside-Out discussion there is ongoing attention to the dry port concept, mainly from a modeling perspective (e.g. [Lattila et al., 2013](#)). We also see that in this period many issues for future research are raised, but so far, few empirical answers are provided. Also, we see that the directional development literature is over time paying more specific attention to inland ports as a planning/governance challenge, although there is still some uncovered ground there. For instance, in terms of understanding the actor constellations which are at place within inland ports; who is involved and why, and who is in charge, is very differentiated. An exemplifying paper in this respect is by [Ng et al. \(2015\)](#), who investigate the dynamics between institutions and the governance of transport infrastructure projects. Another example of governance, albeit at the terminal level, is by [Monios \(2015\)](#). He concludes that if policy goals of modal shift are to be achieved, intermodal transport can no longer be considered in isolation from logistics strategies. This means that government money spent on intermodal infrastructure and operational subsidies (usually on terminals in the inland port) must be aligned with an understanding of how intermodal flows are embedded within internal and external relationships, and with other logistics decisions. This expanded notion of governance can be taken forward in future research.

Furthermore, we see a quickly growing diversification of contributions to other geographical contexts, notably Mediterranean Europe ([Monios, 2016](#); [Santos and Soares, 2017](#)), Northern Europe/Baltic ([Lattila et al., 2013](#)), Latin America ([Wilmsmeier et al., 2015](#); [Wilmsmeier and Monios, 2016](#)), Asia ([Beresford et al., 2012](#); [Monios and Wang, 2013](#)) and also a focus on specific developing countries, such as Brazil ([Ng et al., 2013](#)). Within Northwestern Europe it can be observed that research increasingly focuses on case studies and empirical studies and is slowly moving away from merely conceptual contributions ([Van den Heuvel et al., 2013](#); [Wiegmans et al., 2015](#)). In general, we can see more attention paid to the impacts of institutions in country-specific contexts on for instance transportation systems and regional economic development ([Ng et al., 2013](#)), at the expense of conceptual advancements on port regionalization and/or directional development ([Bask et al., 2014](#)).

In recent years, we observe a decreasing interest in advancing the regionalization concept, but still, the operational perspective remains covered in some contributions (e.g. [Smid et al., 2016](#); [Jeevan et al., 2017](#)). There is also a growing interest in the incorporation of other disciplines into inland port research, such as an integrated spatial perspective (e.g. [Debie and Raimbault, 2016](#)) or an evolutionary and institutional economics perspective (e.g. [Notteboom et al., 2017](#)). Most contributions now take a case study and/or empirical approach (e.g. [Witte et al., 2016, 2017](#)). In this period, the geographical focus has fully developed into a global one and all continents are involved in inland port research.

When considering the 'move away' from the regionalization concept (see [Santos and Soares, 2017](#)), the opening up towards other theoretical perspectives, the growing body of empirical contributions and the wide variety of geographical contexts covered, it can be argued that inland port research is maturing into a more 'stand-alone' research area. In the next paragraph, it is therefore explored what gaps can be identified to inspire future research on inland ports.

#### 4.4. Research gaps and challenges for practice

We observe some remaining research gaps focusing on the spatial, institutional and economic dimensions of inland port development. These mostly result from impediments still experienced in development and operations regarding land use, infrastructure, finance, environment and institution/regulations (Roso, 2008; Roso and Lumsden, 2010). In the economic dimension, although some attempts have been made (Witte et al., 2014; Raimbault et al., 2015; Monios, 2016), little systematic local and regional attention is conducted on the regional-economic dimension of inland port development. This especially concerns local and regional economic development opportunities originating from inland ports benefitting inland port hosting municipalities and regions.

From a spatial perspective, very few local governments have specific spatial development plans for their inland ports. Although for instance Witte et al. (2016) already pay attention to the governance of inland ports, much more can be done in an Inside-Out approach, where municipalities and inland ports develop their inland ports based on a clear and shared vision. All elements that come back in the Outside-In approach are then dealt with, but from the point of view of the inland location. At the same time, there often is a lack of expertise at local and regional levels. This is for instance reflected in the poor attention paid to inland ports in governmental policy documentation on the local to regional level (see Witte et al., 2014, 2016). This means that private actors (consulting agencies, transport operators, and proposed customers) often take the lead in setting the agenda for developments (Bergqvist, 2008). Analyzing in a reliable number of cases how local and regional authorities deal with inland port development and what are successes or failures is an interesting area for further research, also outside of the academic realm.

From the institutional dimension, competition between different regional inland ports could be regarded a research gap. If national policies are not implemented well on regional and local levels it could lead to the uncoordinated development of inland ports in the wrong places decided upon based on the wrong arguments and evaluation frameworks (Bergqvist et al., 2010). Involvement of seaports in inland port ownership is also a more recent development that might be regarded as a research gap.

Following the suggestions of Caris et al. (2014) on research challenges for inland waterway terminals, we can develop some challenges for the operational side of the inland port environment. Studying efficient inland port operations could be encouraged. This encompasses good intermodal connections (bulk and containers) for the inland port. Efficient operations of more tailor-made models could be developed for inland ports that focus on location determination, and also on the added value of the inland port for the inland port hosting municipality and region. External cost modeling is interesting. From a total transport system perspective and maybe also from a seaport perspective, inland port development can be perceived as environmentally friendly. However, external effects (emissions, congestion, nuisance, etc.) are also exported into the hinterland. So, from the perspective of the inland port hosting municipality, these developments might not be as beneficial as sketched in most Outside-In approaches. Data are an important issue for inland ports. Not much data is available and this is also reflected in the research study objects. More data gathering on the inland port municipality and regional level should be encouraged to be able to perform more quantitative oriented studies into inland ports.

#### 5. Conclusion and discussion

The past twenty-five years of research on the topic of inland port development have shown that the concept is clearly much richer and more diversified than merely an extension of seaports or port logistics. However, a recurring issue is also the difficulty of grasping the different definitions, actors, functions, levels and geographies that are of

relevance. This literature review paper has therefore systematically analyzed 80 international peer-reviewed academic journal papers on inland port development between 1992 and 2017. The paper has structured the empirical insights concerning inland ports through different time periods, in different geographical settings and by different analytical dimensions (including key definitions, themes, authors, and conceptual and methodological approaches). The results show that the attention to inland ports in academic literature has been rising since the early 2000s, with a sharp increase in the 2012–2017 period (47 publications) owing to agglomeration of papers in some special issues and in key journals. Within this trend, attention to inland ports is diversifying both looking at the range of journals covered, as well as geographically speaking. Up to now, the research designs of the analyzed papers have been dominated by conceptual studies or case studies. As the identified research gaps also show, more ground could be covered in terms of additional empirical studies on the topic of inland ports.

The literature review has revealed three different periods in which the debate on inland ports has evolved alongside various conceptual, methodological and geographical lines. In the early stages from 1992 to 2005 the inland port concept gradually became embedded in the wider debates on port system evolution, which is captured at the end of this period by the influential article on port regionalization by Notteboom and Rodrigue (2005). In this period, the inland port is not central to most analyses and the geographical focus is mostly limited to the North-American and European context. This is changing in the second period from 2006 to 2011, where a diversification of the subject can be observed. The dry port concept (Roso, 2007) is gaining more prominence, as is the theoretical and conceptual advancement of port regionalization, which also broadens up the geographical focus towards Africa, Asia and the Pacific. Here we also see that the early conceptualizations of inland ports (e.g. port regionalization) might have consolidated a ‘tweaked’ focus on the perception of inland ports as just being a component of the transport/logistics system, and not much else.

The contextualization stage (2012–2017), characterized by the implementation of the directional development perspective, i.e. the Outside-In, Inside-Out discussion (Wilmsmeier et al., 2011), is slowly changing this pattern. It nuances the dominant transport/logistics/supply chain systems perspective in which inland ports were mainly ‘followers’ and in contrast puts more emphasis on the spatial and institutional dimension of inland ports, where inland ports can also have more leading roles in regional systems. Clearly, we see more attention to institutional/governance perspectives especially after 2012 (Fig. 2). This observation is further supported by a geographical focus that keeps shifting away from the traditional North-American and European cases towards a wide array of empirical examples in various geographical contexts over the whole world, in particular Mediterranean Europe, the Baltics, Latin America and Asia. This is largely at the expense of the port regionalization idea, which was also observed in the conceptual advancements presented in Fig. 2, where it was shown that ‘older’ concepts gradually give way to ‘newer’ ones, while these newer ones are building on the conceptual foundations of the older ones.

Overall, it is striking to find that over time much attention has been paid on inland ports as undervalued components of the maritime ‘transport/logistics/supply chain’ systems (‘follower’), while their roles as components of the ‘local and regional’ transport systems (‘leader’) are only in the most recent period attracting more attention. It could be argued that the early conceptualizations of inland ports (e.g. port regionalization) have even consolidated this focus on the importance of the maritime supply chain. This has pushed researchers, planners and policymakers to perceive inland ports as ‘just’ being a component of these maritime-oriented transport/logistics system. Such a tweaked focus is likely to pose significant impacts on planning, management, and governance of inland ports. In fact, this might also affect how the management structure of inland ports is designed and implemented.

Needless to say, many conceptual, methodological and empirical questions still lay ahead as also discussed in the identified research gaps

throughout the paper and especially in the previous section. The move away from the regionalization concept opens up new directions for planning, management, and governance of inland ports, both in terms of research and practice. A look outside of the academic fences into the ‘grey’ literature (professional literature, policy reports, etc.) might further enhance our understanding. In particular, studying efficient inland port operations, tailor-made models for development and operation of inland ports, regional-economic development opportunities,

specific localized, contextualized spatial development plans and institutionalization of inland ports governance could further substantiate the consistently growing body of literature on inland port development.

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**Appendix A. List of journals (sorted alphabetically)**

*A.1. Journals analyzed with papers used in the literature review*

- Asian Journal of Shipping and Logistics.
- Case studies on Transport Policy.
- Cities.
- Eurasian Geography and Economics.
- GeoJournal.
- Growth & Change.
- International Journal of Physical Distribution & Logistics Management.
- International Journal of Urban and Regional Research.
- Journal of Transport Geography.
- Maritime Economics and Logistics.
- Maritime Policy & Management.
- Regional Studies.
- Research in Transportation Business and Management.
- Research in Transportation Economics.
- Tijdschrift voor Economische en Sociale Geografie.
- Transport Policy.
- Transport Reviews.
- Transportation.
- Transportation Journal.
- Transportation Research Part A: Policy and Practice.
- Transportation Research Part B: Methodological.
- Transportation Research Part D: Transport and Environment.
- Transportation Research Part E: Logistics and Transportation Review.
- World Review of Intermodal Transportation Research.

*A.2. Journals analyzed, but without relevant publications on inland ports*

- Economics of Transportation.
- Environment and Planning A.
- Environment and Planning C: Government and Policy.
- Environment and Planning D: Society and Space.
- European Journal of Transport and Infrastructure Research.
- International Journal of Shipping and Transport Logistics.
- Journal of Transport and Land Use.
- Journal of Transport, Economics and Policy.
- Marine Policy.
- Transportation Letters.

**Appendix B. Reviewed papers across journals over time**

Journal	1992–2005 <i>Regionalization</i>	2006–2011 <i>Diversification</i>	2012–2017 <i>Contextualization</i>	Total papers per journal
Journal of Transport Geography	2	8	10	20
Maritime Policy & Management	1	2	3	6
Research in Transportation Business & Management	–	–	6	6
World Review of Intermodal Transportation Research	–	2	4	6
Maritime Economics & Logistics	–	1	4	5
Research in Transportation Economics	–	4	1	5
Transport Policy	1	1	3	5
GeoJournal	–	2	2	4
Transportation Research Part A	1	–	3	4
International Journal of Physical Distribution & Logistics Management	1	1	–	2
Tijdschrift voor Economische en Sociale Geografie	1	–	1	2



Transport Reviews	–	–	2	2
Transportation Research Part E	–	–	2	2
Asian Journal of Shipping and Logistics	–	–	1	1
Case studies on Transport Policy	–	–	1	1
Cities	–	–	1	1
Eurasian Geography and Economics	–	1	–	1
Growth & Change	–	–	1	1
International Journal of Urban and Regional Research	–	1	–	1
Regional Studies	–	–	1	1
Transportation	1	–	–	1
Transportation Journal	1	–	–	1
Transportation Research Part B	–	–	1	1
Transportation Research Part D	–	1	–	1
<b>Number of papers per time period</b>	<b>9</b>	<b>24</b>	<b>47</b>	<b>80</b>

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