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Sustainability in Port Cities – a Bibliometric Approach

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Abstract

The paper uses a bibliometric approach to quantitatively assess current research trends on idea of sustainability in seaport cities. Content, structure and connections between port city and sustainability issues are especially looking for. The aim is to get an overview of that research field, find how different subfields are connected and find the potential opportunities for bridging the gaps between subfields. The tools of bibliometric analysis – a map of the links between the keywords and keywords density map – are used to identify important areas in port city research field. Findings show that the most important research field of port city can be divided into four clusters which are devoted to environmental issues, port activity, waterfront development and sustainability matters.

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Keywords: port city; seaport; sustainability; bibliographic analysis

1. Introduction

Sustainability is a very important topic discussed at the level of states, institutions and enterprises. It is also an important issue for many seaports, port companies and municipal authorities. Although the idea of sustainability is understood in a similar way by all, each of the above-mentioned entities representing the port on the one hand and the city on the other has its own areas and ways of its implementation. The key sustainable matters for cities are associated with sustainable transport, architecture, spacial development, energy use and others. Sustainable Cities and Communities is the goal number 12 among the collection of 17 Sustainable Development Goals set by the United Nations in 2015. All solutions applied in that field should contribute to create a better place to live. In port

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cities it is especially important to care about sustainable problems because of pollution and noise caused by ships being handled at port and other port activity. In port cities there are more factors that influence the air quality comparing to inland cities, the most important of which are ships' engines emissions. The directions of application and achieved effects of sustainable solutions combining business, ecological and social aspects are of practical importance as well as scientific interest. This article proposes an analysis of scientific literature from the port city area with particular emphasis on sustainability matters. The aim of this paper is to identify dominant sub-fields from port cities research field and find out how they are connected with each other.

2. Literature review

The bibliometric analysis of port-related area, known from the literature, concerns the review of articles focused solely on ports or, more broadly, the maritime industry. Papers which are in the area of interest focus on the analysis of the literary output that has been created over the years within the scope of port economics, management and policy research field. Past research show that most port-related papers focus on regional port systems (e.g. port ranges, multi-port gateway regions) and national port systems as well as individual seaports or terminals. Significantly lower number of papers has pure theoretical character (Notteboom, Pallis, De Langen & Papachristou, 2013). Research interests in the field of port studies are divided into several categories, which are presented in Fig. 1. This scheme is based on the analysis of articles from 1997 - 2008.

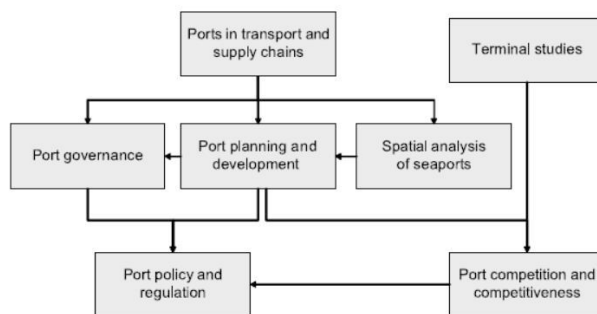


Fig.1. Relations between different categories of port studies, Source: Pallis, Vitsounis, De Langen & Notteboom, 2011

In recent studies, this division is preserved, although further areas of interest are added. Shi & Li propose a very similar segmentation of topics, but it is worth noting that one additional area has been distinguished - port risk and security (Shi & Li, 2017):

- Ports in transport and supply chain
- Port governance, port policy, regulation, and legal issues
- Port planning, development, cluster, network, and economic impact
- Port management, service, performance, efficiency, and competitiveness
- Port choice
- Port risk and security
- Other: spatial analysis, employment, academic research, etc.

The problems mentioned relate to various issues, including both the spatial development of the port and the organization of transport, important from the point of view of the connections with the city. However, port sustainability issues are not indicated as a separate research category.

Another interesting issue is the identification of the main trends of research focusing on the specificity of port cities. Literature devoted to the relationship between the seaport and the port city includes several thematic areas. Two streams of literature are mentioned as the most important, but it should be remembered that a clear division is not always possible, and some of the problems discussed in the research are included in both thematic groups. The

first research area is devoted to the port - port city relations in a spatial aspect, while the second covers the issues of port-centric freight flow from logistics perspective (Fig.2).

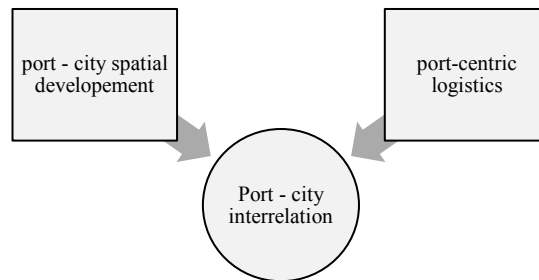










Fig.2. Main research fields in area of port – city interrelation.

Source: adapted from (Jason Monios, Rickard Bergqvist & Johan Woxenius, 2018)

The interests of the first thematic group perfectly represent the ones developed by Hoyle in 1988, and then developed by subsequent authors, a systematic summary of port - city relationships development over the years (Table 1). That classification is a base for other models of ports and cities transformation stages, for example with the division into Western and Asian Models (Lee, Song & Ducruet, 2008). Table 1 shows that the changes that have occurred over decades have begun with the close interdependence of the port and the city, and then entered the phase of weakened links between port and city. It is pointed out that the current relationship between the port and the city is at the stage of transformation associated with industrialization, transformation of the maritime economy, the growth of port, city and region.

Table 1. Evolution of the port-city interface.

Stage	Symbol City  Port 	Period	Characteristics
Primitive port/city		Ancient/medieval to 19 th century	Close spatial and functional association between city and port.
Expanding port/city		19 th – early 20 th century	Rapid commercial/industrial growth forces port to develop beyond city confines, with linear quays and break-bulk industries.
Modern industrial port/city		mid 20 th century	Industrial growth (especially oil refining) and introduction of containers/ro-ro require separation/space.
Retreat from the waterfront		1960s – 1980s	Changes in maritime technology induce growth of separate maritime industrial development areas.
Redevelopment of waterfront		1970s – 1990s	Large-scale modern port consumes large areas of land/water space; urban renewal of original core.
Renewal of port/city links		1980s – 2000+	Globalization and intermodalism transform port roles; port-city associations renewed; urban redevelopment enhances port-city integration.

Source: Hoyle, 1989; Hesse, 2013.

Initial strong interdependencies of the port of the city were gradually weakened. The main factors that have favored a port-city disconnection are (Rodrigue, 2017):

- The migration of several terminals towards peripheral locations. The need for additional space and deeper drafts have driven terminal operators to seek new sites that are located further away from the conventional sites.
- The containerization has reduced labour requirements since a modern container terminal is capital intensive and require a small quantity of qualified labour to operate. Port terminal thus employ much less people than before, reducing a whole array of port - city interactions, such as commuting.
- Safety and security issues have made access to port areas, particularly terminals, more restricted.
- Modern ship operations require less labour. Also, due to flags of convenience, ship labour is mostly multinational (e.g. Philippines) and therefore not linked to the communities along the ports of call. Containerships spend little time at ports, often less than 24 hours, considerably reducing opportunities for shore leaves.
- Hinterland accessibility has improved, implying that the majority of economic activities using the port are located further inland and not, as it was conventionally the case, in close proximity to port terminals.

Despite above mentioned trends of disconnecting ports and cities Hall and Jacobs point out that still two-thirds of the world's major ports are located in unambiguously urban space. As many as 52 port complexes out of 76 top container ports and bulk ports are in urban agglomerations of 1 million or more people. As a result, ports continue to occupy urban spaces, use infrastructure and urban labour markets as well as other resources. Ports still located in cities face challenges such as congestion, air pollution and noise which are, among others, results of port activity.

Relations of the port with the city can be analyzed also from the point of view of implementation and coordination of flows of cargo streams between these entities, and further to the port facilities. This subject is within the concept of port-centric logistics, which is defined as the provision of distribution facilities and value-added logistics services at a port (Mangan, Lalwani & Fynes, 2008). Negative effects, which city logistics deals with such as air pollution, noise, traffic congestion lower the living standard in cities. One of the most negative phenomena occurring in modern cities, and resulting directly from the growing transportation needs, is the environmental degradation associated with the destruction of valuable natural and cultural areas. (Iwan & Kijewska, 2016; Łapko, 2014). Port activity amplifies these effects and make a port city less attractive place for living and investing (Zhao, Xua, Wall & Stavropoulos, 2017) The decision of involving in port-centric logistics depends among others on factors such as the availability of land and the quality of hinterland connections. It is more likely to successfully encourage retailers to establish their distribution centres in ports if most goods are imported by sea (Monios & Wilmsmeier, 2012). As an example of such a solution can serve Teesport (third largest port in the United Kingdom) where Tesco located and operates non-food storage and distribution facility. Another example from the same port is PD Port – a logistic company which offers port-centric warehousing in the locations of: Teesport, Billingham, Felixstowe and Swadlincote. PD Ports provides distribution services to a wide range of local and national clients. It operates a fleet of 18 vehicles for local deliveries on behalf of their customers (www.pdports.co.uk, 31.03.2018)

This paper focuses on port cities in the aspect of sustainability. That is why it is important to check which topics of sustainability are of interest of seaports authorities. One of the aims of this paper is to check if these topics turn up in scientific papers and in what context. Ports in their sustainability reports and on their websites use several terms and management approaches which are connected with the sustainability concept, for example corporate social responsibility CSR, environmental responsibility, social responsibility, sustainable development, green marketing or triple bottom line. Regardless of the term, the intent is to reflect business responsibility for the wider societal good (Crittenden, Crittenden, Ferrell, Ferrell & Pinney, 2011). They all have been employed to demonstrate business accountability to society.

Larger ports, which usually have a more developed marketing strategy, more and more often publish sustainability reports, which include not only the impact of the port and the vessel handled on air pollution but also including city residents to the group of stakeholders (Wagner, 2017). Topics that are selected by the ports and discussed in sustainability reports are presented in Table 2. Special attention is paid to these words in the analytic part of this article.

Table 2. The most important sustainability topics in selected seaports

Hamburg	Antwerp	Gothenburg	Bremen and Bremerhaven	Rotterdam
Ecology:	Shipping	Financial responsibility:	Governance:	CO ₂ emission,
Ecological transport chains	Mobility	Satisfied customers,	Compliance,	Port Safety,
Land conservation	Employment & safety at work	Development of the freight hub,	Port securing,	Best quality service,
Nature protection	Economic activity	A stable economy,	Sustainable purchasing,	Stakeholder communication,
Climate protection	Nature & environment	Strong business ethics,	Economic performance:	New markets development,
Society:	Energy & climate	Environmental Responsibility:	Competitiveness and major projects,	High growth markets,
Occupational safety/	Research & Innovation	Climate,	Economic value and indirect economic impacts,	Digitalisation and cyber security,
Health promotion	Society	Biodiversity,	Future-orientated infrastructure and adaptation to climate change,	Efficient and agile organisation,
Staff development	Circular economy	Air emissions,	Environmental compatibility:	Knowledge and innovations,
Social responsibility	Safety & security	Efficient use of resources,	Use of resources and recycling in port construction and maintenance,	Employment,
Economy:		Social responsibility:	Effects of maintaining the water depths,	
Added value		Work environment,	Energy management & climate protection,	
Business partners		safety and health,	Efficient land use & biodiversity,	
shareholders		Diversity and equal opportunities,	Environmentally friendly shipping,	
		Non-discrimination,	Staff and labour	
		Skills development,	Practices:	
		Reduced exclusion,	Attractive working conditions,	
			Fair working conditions,	
			Occupational health and safety	
			Social Responsibility:	
			Impacts of the ports of Bremen on the population,	

Source: Own study based on sustainability reports of selected ports

This paper is in line with the previous work (Pallis, Vitsounis, De Langen & Notteboom, 2011), however, it narrows the subject of research to the port city in a sustainability aspect. The database of comparative articles is also selected in a different way. Some authors (Notteboom, Pallis, De Langen & Papachristou, 2013) use articles published in one, others in several selected journals devoted to maritime issues (Shi & Li, 2017). This article uses articles indexed in the Web of Science citation service. It also uses visualization, which is a tool not used before in bibliometric studies on port cities.

3. Research methodology

In this paper port cities research area is analyzed with the use of bibliometric approach. Applied research procedure is presented in Fig. 3. The first step was to obtain a relevant publications information from citation database. The data set used in this study was extracted and downloaded from Web of Science (WoS) Core Collection.

While searching for publications, it is very important to set the research criteria that suit the aim of the analysis. A combination of keywords "port city" OR "sea port city" OR "seaport city" OR "port town" were applied to gather all the publications with those phrases in their titles, abstracts or keywords. The papers published during the period from 1980 to 2017 are included in the study. As a result 524 papers containing such phrases were extracted. In the next step, the retrieved publications were limited to those which are indexed under research categories related to management and economics in the WoS database, including: economics, transportation, business, management, urban studies, geography, environmental sciences, environmental studies, civil engineering, planning development, transportation science technology, Asian studies, operations research & management science, water resources, geosciences multidisciplinary.

The extracted records were analysed for bibliometric characteristics such as trend in publishing, belonging to the research category and mapping of frequent terms in publications pertaining to port cities. The analysis was performed with the use of the VOSviewer software and the analytical tool available at the Web of Science.

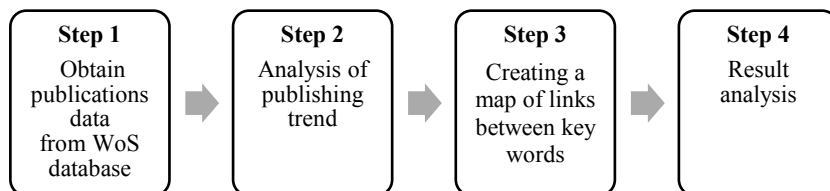


Fig. 3. Research procedure (Source: Own elaboration).

4. Sustainable port cities – bibliometric analysis

Fig. 4 plots the annual trend of publications related to port cities. In the first half of the analyzed period there were not many papers and they were published in an irregular manner. There were years when this topic has not appeared in scientific journals even once. In last ten years systematically more and more scholars started doing research in this field. 2014 was particularly fruitful in terms of the number of publications.

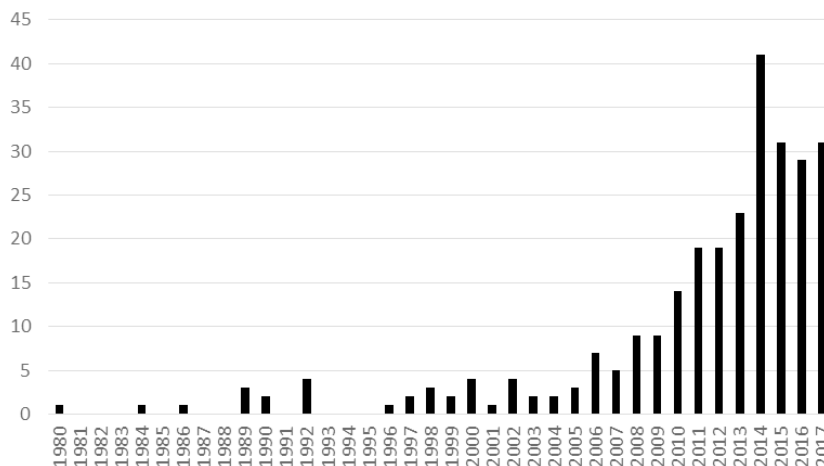


Fig. 4. Publishing trend in the area of port city (Source: own realization based on Web of Science analytical tool).

Most publications from port city area focus on “spacial” problems and belong to “geography” and “urban studies” research area (Table 3). However, there are also articles associated with environmental problems, economics and engineering research fields.

Table 3. The top ten research categories of port city related publications

Category	Number of publications	Percent of 273 publications
Geography	59	21.6
Urban studies	57	20.9
Environmental sciences	49	17.9
Economics	38	13.9
Environmental studies	36	13.2
Transportation	34	12.5
Engineering civil	23	8.4
Planning development	21	7.7
Geosciences multidisciplinary	19	7.0
Green sustainable science technology	12	4.4

Source: Own realization based on Web of Science analytical tools

Structure The authors with the largest number of port city publications include: C. Ducreut, J. Wang and B. Hoyle. Their works belong to the group of spatial analysis of developmental relations between the port and the city, integrating port cities into production network, benefiting from port cities for globalization and participation in international supply chains. Port city planning is the most represented group of topics. Similar conclusions can be drawn regarding scientific conferences that took place in previous years and the proceedings of which were indexed in the Web of Science. Most often, the keyword “port city” together with its various variants appeared at the annual ISOCARP CONGRESS. It is a conference devoted to spatial planning in cities. The issues of development and revitalization of port cities is one of the topics discussed, although not the most important.

The top three keywords with their number of occurrences are shown in Table 4. The keyword “environment” has the highest frequency of 34. Keywords such as “sustainable development” and “sustainability” (not presented in table 4) have the frequency of 13 and 11 times accordingly.

Table 4. The occurrence of three key terms in port city related publications.

Term	Occurrence
Environment	34
Population	23
Waterfront	20

Source: Own realization based on VOSviewer software

The keyword co-occurrence network of port city was constructed with the use of the VOSviewer software. Binary counting method was applied, which means that if a noun occurs only once in the title and abstract of a publication it is treated in the same way as a noun that occurs several times. The size of the nodes and labels in Fig. 4 is determined by the weights of the item. The higher the weight of an item, the larger the label and the node. The distance between two nodes represents the strength of the link between them. A shorter distance generally reveals a stronger relation. The nodes with the same colour belong to a cluster. A cluster is a set of closely related nodes (van Eck & Waltman, 2014). To make it more visible in black and white, the clusters are circled and numbered.

Results from the analysis done with VOSviewer divide the keywords into four clusters, which categorise the dimensions of port city research. On the map (Fig.5), connections with sustainable development idea are sought after in particular.

The first cluster is the strongest one with the largest group of words (20 words). It concentrates on research field devoted to port activity. The most popular keywords included in this cluster are “space”, “integration” and “opportunity”. Among all clusters, this one is the most port-related. Here are, for example, the terms “port authority”, “port activity”, “port area”, “port function”, as well as terms indicating the problems of port development and investment. There is also the term “stakeholder”, which suggests the cluster's connections with sustainability.

The second cluster is of similar size (19 words) to the first one and is focused on environment. It is devoted to environment in the context of climate change, emission and air pollution. Besides the environment also people are important in this cluster. The social aspect is present thanks to words such as “population”, “person” and “inhabitant”.

Third cluster is devoted to architecture. That group of words draw attention to problems connected with changing purpose of waterfront towards using it for urban purposes. The most important keywords within this cluster are: “waterfront”, “planning”, “site”, “urban space” and “territory”. It is the only cluster where no direct sustainability-related words can be found.

The forth cluster is not of significant size (six words), however, is very interesting. It is focused exclusively on sustainability matters. The most frequent terms put in this cluster are: “community”, “trend”, “society”, “sustainability” and “sustainable development”. The last two words are indicated by separate nodes. These keywords are connected with many words from other clusters. Despite these connections they make a separate topic group. The fact that they were, with several other words, distinguished as a separate cluster, may indicate that a new research field concerned around sustainability matters occurred.

In all clusters, with the exception of the third one, one can find terms that reflect the sustainability character of ports quoted earlier in Tab. 2. Attitude toward this concept can be identified because of the presence of words from two areas: environment and society. They can be found in the first and second cluster.

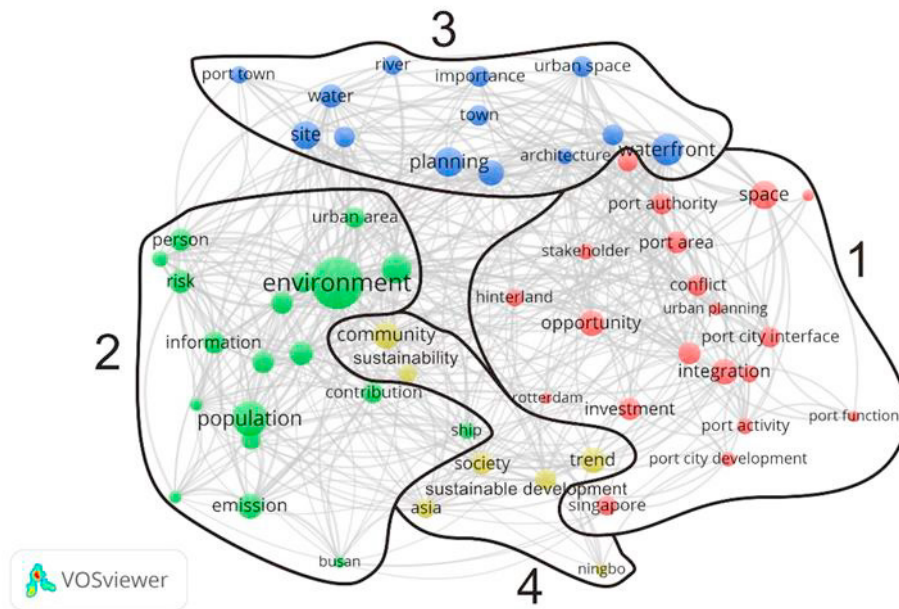


Fig. 5. Map of links between analysed key words (Source: Own realization based on VOSviewer software)

The analysis of Fig. 5 also allows to find regularities related to the methods of conducting research in the analyzed port city area. The large number of names of specific ports and geographical areas indicates that articles are often a case study describing the problems of port cities on specific examples. The most frequently analyzed ports were: Singapore, Ningbo, Busan and Rotterdam.

All found dependencies fall within the scope of research defined in literature review as port - city development. Among the most recurring terms there were no words from city logistics or port-based distribution research field.

The closest to this type of issues would be the first cluster, where the “port functions” and “port activities” were located. However, it was expected that terms such as freight, flows or logistics would be found. It turned out, however, that they are not frequently used in articles. Therefore, this area of research can be considered not very popular. The organization of freight deliveries between the port and the city is not a popular research topic as well. Ports are treated as logistics centers, but rather in the context of links in supply chains rather than links with the city.

Fig. 6. presents the visualisation of analysed key words density. The largest number of items with the highest weight are located in the neighbourhood of terms: “environment”, “population”, “waterfront” and “integration”

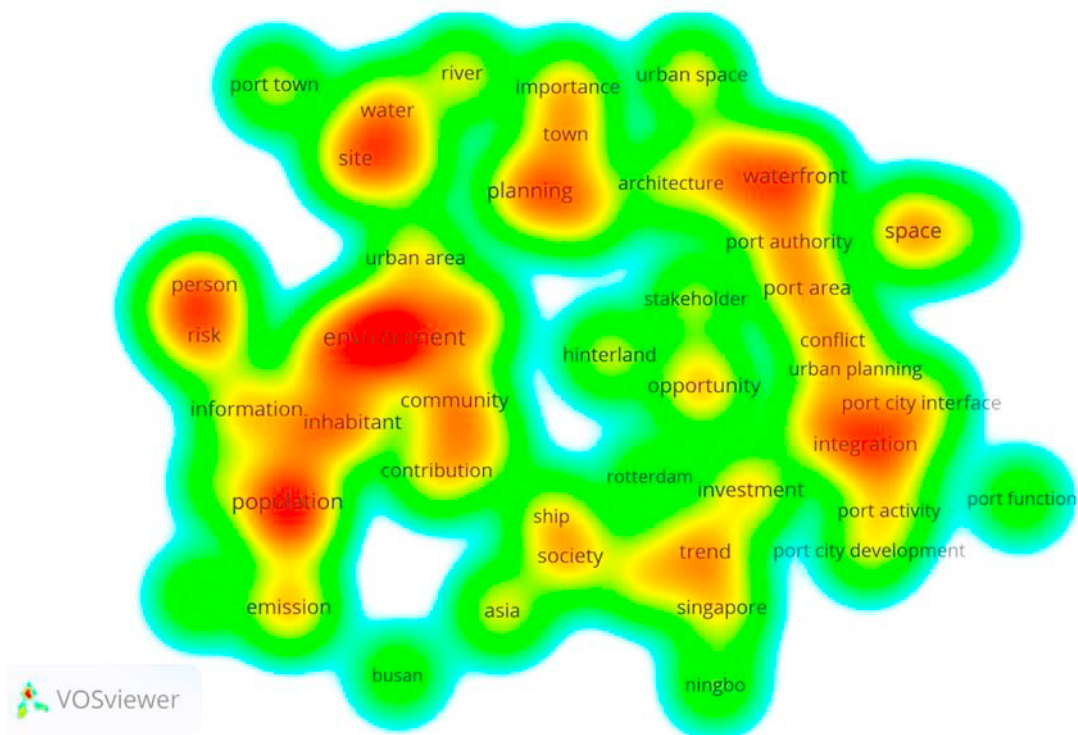


Fig. 6. Map of analysed key words density (Source: Own realization based on VOSviewer software)

Conclusion

The adopted research area was scientific achievement devoted to port cities. Main research sub-fields (clusters) were identified in port cities studies. Four clusters were identified corresponding to the following issues:

- port activity,
- environment and population,
- architecture,
- sustainability.

Among each of those areas the links between port cities and sustainable development were looking for. The results showed that sustainability issues were very popular. There were studies that focused on the issues of holistic sustainable development approach to port cities - a cluster especially devoted to sustainability matters. On the other hand, there were research papers that not always directly referred to all aspects of sustainability, but focused only on same facets. In that case authors often selected individual elements. These include for example environmental protection issues, in particular air pollution, or the role of community and stakeholders. The result of such approach is that key words from sustainability field can be seen not only in “sustainability cluster” but also in most of other clusters identified in this paper. It means that ecological and social matters were very important for many research

areas concerning port cities. Traditional topics from port activity and functioning were enriched by new content – different aspects of sustainable development. These aspects are convergent with key words from port sustainability reports (presented in table 2).

Keywords from ports sustainability field can be found in papers presenting crosscutting concepts and in articles concerned only on singular topic in particular port and city (case study type papers).

A gap in research can be noticed. Most of the analyzed papers belonged to the area of port - city development. Among the most recurring terms there were no words from city logistics or port-based distribution research field. Terms such as freight, goods flows or logistics were not popular at all. The organization of freight deliveries between the port and the city is not a common research topic. Ports are popular subjects of research in the context logistics centers and links in supply chains rather than links with the city. In the future, it would be worthwhile conducting research from the area of sustainable freight deliveries between city and a seaport.

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