

Investigating Port Spatiality: Tools for a Spatial Approach to Port Clusters

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Abstract

Today, half of European port managing bodies administer two or more ports. Contemporary port-city territories are increasingly shaped by processes of “spatial clustering,” which call for a reassessment of the tools used to investigate and design these areas. Port clusterization refers to the administrative aggregation of two or more ports into clusters, a phenomenon that has the potential to affect port spatiality by defining a new spatial typology of ports, characterized by polycentricity and territorial extension. Despite the absence of established theories and tools for analysing such extended spaces, the rise of port clusters is giving way to new governance models for optimizing coastal areas and specializing land–sea infrastructures. This article, part of the EU-funded PULSE (The Port-clUster LandScapE) project, examines the impacts of port clusterization by introducing the concept of “port-cluster landscapes”—whose investigation contributes to developing a spatial and design-based approach to ports. In this context, the port-cluster landscape emerges as a spatial typology of interconnected ports and overlapping flow systems. Methodologically, the article outlines the tools formulated to study two Italian port clusters, including multi-level maps and the Indicator System, a set of 12 spatial indicators conceived within the framework of the project and being applied to these cases. Ultimately, the article explores port spatiality, highlighting the need for new regional collaborations and spatial reconceptualization, which can be fostered through transformative design projects in the context of port clusterization.

Keywords

multi-level maps; port city territory; port cluster; port spatiality; spatial engagement; spatial stretching; technical lands

1. Introduction

1.1. Theoretical Framework

Today, half of European port managing bodies administer two or more ports (European Sea Ports Organisation [ESPO], 2022). According to the ESPO's report *Trends in EU Port Governance*, more and more ports are clustering, either with other ports, or with other stakeholders in the port ecosystem and beyond.

Port clusterization, which involves the administrative merging of two or more ports within the same region, is driving “spatial clustering” processes in contemporary port-city areas. This, in turn, is giving rise to new spatial categories. Deciphering these emerging categories calls for a multidisciplinary approach, mirroring the complexity of the cluster concept in and of itself (Moretti, 2023).

According to Notteboom et al. (2022), “ports clusters consist of geographically concentrated and mutually related business units centred around transport, logistics, trade, and industrial production.” It is interesting to note, from the point of view of “spatial engagement,” how, in their extensive study on the subject, the authors identify important geographical attributes behind port cluster formation, which varies substantially by maritime range, mainly owing to a set of constraints such as availability of port sites (coastal geography and distribution of cities), administrative divisions, hinterland accessibility and density, economies of scale, and infrastructure.

The emergence of port clusters in the European framework aims not only at restructuring port governance, but also at generating new administrative patterns and strategic models to optimize coastal spaces and specialize land–sea infrastructures between the ports of the same cluster. Many of today's challenges, such as geopolitical changes or tensions, energy transition, the increase in scale and integration of the maritime sector, or technological complexity, may be beyond the possibilities of a single port management body. Additionally, the scarcity of available port land on the other hand expands the possibilities for port cooperation (ESPO, 2022).

Port clusterization is heavily impacting the institutional sphere of ports; however, in this process, not only does this phenomenon have no control over cities, but its spatial component is being overlooked. Recent contributions have denoted that key issues related to spatial dynamics in port clusters remain unexplored (Ducruet & Notteboom, 2020; Moretti, 2023; Pavia, 2016). Even in a broader outlook, according to geographer Vorley (2008), while the concept of the cluster is largely used to describe agglomerations, interconnected networks, and concentrations of firms, its spatiality is less clear. Intended as an evolution of the “port regionalization” phenomenon (Notteboom & Rodrigue, 2005), port clusterization has the potential to radically transform areas that are becoming increasingly extensive and complex. It doesn't concern only a supplanting of administrative borders, but an intense “spatial stretching”: a physical expansion of coastal and marine areas that, through these developments, evolve into interconnected, multidimensional spaces. This stretching generates new spatial patterns of functional relationships for port–city–territory interfaces (Robinson, 1968), including the infrastructure and architecture systems that serve as both barriers and connectors between land and sea.

With this approach, port clusterization does, in fact, affect space. It defines an unprecedented typology of ports which embodies the principles of physical proximity and functional complementarity that several port cities have been pursuing for decades, aiming to replace the obsolete idea of competition between neighbouring ports. The concept of cluster sharply introduces the networked dimension of contemporary territories: a dimension that goes beyond the investigation of individual polarities and replaces them with polycentric visions.

1.2. Main Argument

The main argument of this contribution lies in advocating for the investigation of the spatial products of port clusterization—which the study calls port-cluster landscapes—with spatial design tools. The port-cluster landscape is introduced as a form of port spatiality consisting of multiple ports and overlapping global and local flow systems that, together, produce an unexplored spatial figure within the built environment. As an overarching goal, the contribution questions how, at the introduction of port clusterization, it is imperative to formulate tools that encourage new regional collaboration and spatial reconceptualization.

The study is carried out in strategic contexts in Italy where the merging of ports is relatively recent and allows an observation of the unfolding process. The identification of spatial indicators and multi-level mapping, as the article will deepen, are the key tools to develop spatial knowledge and design practice for architects, planners, and governing bodies to contribute to the understanding of port clusters.

Numerous studies dealing with urban-port spatial conditions have defined the nature of the port-city relationship by mainly focusing on the characters of the interface between the two entities. Renowned are the contributions of maritime geography in this field, among them Brian Hoyle for whom the port-city interface may be described as a system, or as a concept, or as a series of mechanisms that link port and city (Hoyle, 2006). The work of Hayuth (1982) was among the first to introduce the idea of the port-urban interface area as a zone in transition. His research reflects on the land-use characteristics of the urban waterfront in the new era of ocean transportation when, at the end of the 20th century, the coexistence between city and port became conflictual and spatial segregation increased.

More recently, other theories introduce the regional dimension that transforms ports into large-scale exchange nodes (e.g., the aforementioned port regionalization) and the economic component that drives the formation of port clusters. Following these studies, we witness a process of clustering of ports that, on the one hand, concerns the "clustering of ports around a maritime range," and, on the other hand, encompasses the "clustering of activities around a port" (Notteboom et al., 2022). Both processes do not appear to provide a comprehensive image of the spatiality of the cluster, of what its formal and settlement characteristics are, or what its spatial repercussions are on contemporary urban-port features.

In this evolving framework, it is believed that the concept of port-cluster landscape can challenge existing contributions and extend the field of studies on urban-port spatial conditions. Exploring the impacts of port clusters on space will push research beyond its current boundaries by addressing a crucial yet underexplored phenomenon. If the idea of the city-port interface, although groundbreaking at the end of the last century, today refers to a dimension that is conceptually distant from the systemic approach of contemporary ports, the port-cluster landscape refers, instead, to a new polycentric feature.

Believing that the formalisation of port clusters can generate a landscape of its own, able to surpass the idea of individual cities, contributes to understanding new networked built forms that have recently been emerging, as results of broader processes of global urbanization. The concept of port-cluster landscape deals with the spatial qualities of active urban-port territories, complementing the definition of port clusters traditionally employed in maritime economics. Not only “clusters of companies and economic activities” (Notteboom et al., 2022), but also “new types of landscape” produced by institutional transformations. Here the use of the term “landscape” is key because it refers to landscape urbanism theory, with which Charles Waldheim highlighted the process of semantic emphasis that, since the late 20th century, enriched the notion of “landscape(s)” (Waldheim, 2016). If it was conceivable to rethink the city through landscape, why not rethink the port through it too?

As part of the ongoing EU-funded research PULSE—The Port-clUster LandScapE: Developing a Spatial and Design Approach to Port Clusters (see Acknowledgments), this article introduces the set of tools built to study the spatial impacts of port clustering in two Italian port contexts.

1.3. Structure of the Article

Section 1 includes the theoretical framework of the contribution framed in relevant bibliographical references and previous publications by the author. The main argument is outlined by specifying the potentiality to study the spatial footprint of port clusters, and by detailing the research’s funding context.

Section 2 opens by establishing theoretical-lexical assumptions about the terms used in the research. The terms here shown—“cluster,” “system,” “region,” and “port city territory”—are employed to define regions of meaning.

Section 3 delves into the phenomenon of port clusterization in Europe, presenting it as an evolving scenario. It illustrates the methodological structure of the study, highlighting its general approach, research phases, and their corresponding Work Packages (WPs). The section also shows the toolkit as the final result of the study.

Section 4 presents the Indicator System and the mapping activity. To do so, it provides a description of the 12 spatial indicators, as well as a first version of the multi-level maps featuring the Port Network Authority of the Eastern Adriatic Sea (Ports of Trieste and Monfalcone).

Section 5 addresses port spatiality in its polycentric and polymorphic nature. Concluding with an open debate, the article shows how the concept of port-cluster landscape can be applied in the fields of architecture and design of port cities, and it also presents first design recommendations and routes that will be taken to ensure the exploitation of research results.

2. A Glossary of Port Spatiality

The terminology we use in scientific reasoning mirrors the fields of research in which we claim to position our work. A study that centralizes the process of port clusterization and the notion of cluster, hence, questions neighbouring terms with the intention of delineating the focus of its reasoning. Besides, the more the concept of cluster is interdisciplinary, the more meaningful is the search for a common language.

Specifically, the glossary developed in this study features 12 terms: “cluster,” “comprehensive & core port,” “hinterland,” “logistics zone,” “network,” “port catchment area,” “port cityscape,” “port city territory,” “range,” “region,” “seaspace,” and “system.”

As a main goal, connections were sought between the 12 terms and the notion of space. Namely, it was examined whether and how the terms had implications and declinations related to the spatiality of territories. The glossary questions whether there is a spatial embedding, and/or a spatial engagement of these terms and how this may influence urban design and architecture.

To give a sample, some terms from the glossary—i.e., “region,” “port city territory,” “system,” and “cluster”—are reintroduced below. They provide a theoretical-lexical basis for the article and motivate the use, in the study, of the term “cluster” instead of “system,” and the formula “port city territory” instead of port city “region.”

In a more unified reading of the four terms, we can critically examine them through two binomials (“cluster”/“system” and “region”/“port city territory”) that do not necessarily put them in contrast but interpret them through a comprehensive and integrated approach. If the notion of “system” refers to a mechanical dimension that indicates (and requires) physical proximity between the constituent parts, that of “cluster” is instead a broader construct, conceptually and physically. Transcending administrative and political boundaries and the geographical closeness of the system poles, it concerns the set of tangible and intangible relations that develop between ports and port-related activities on land as well as on sea, realizing the stretching process already mentioned. Focusing instead on the “region”/“port city territory” binomial of terms, it is considered that the notion of “port city territory” is not only more all-encompassing than that of “region” in order to develop a study on port clusters, but is able to capture the territorial heterogeneities and the spatial footprint that mark clusters’ form and structure. “Port city territory” is a term that is capable of considering the terrestrial hinterland as well as the maritime hinterland of a port city, thus generating a third type of space that, indeed, demands new definitions. The term “region,” on the other hand, keeps a descriptive nature and, consequently, lacks operational explanatory power. Although this term, thus understood, encompasses the network of logistical corridors gravitating around a port, it often has some correspondence with administrative and legal boundaries, making reasoning less flexible.

2.1. Cluster/System

First defined by the Belgian scholar Haezendonck, the port cluster is described as follows:

The set of interdependent firms engaged in port related activities, located within the same port region and possibly with similar strategies leading to competitive advantage and characterized by a joint competitive position vis-à-vis the environment external to the cluster. (Haezendonck, 2001)

The cluster is a “driver.” It fosters the competitiveness of industries, increases the productivity and efficiency of clustered locations, stimulates and enables innovation, and facilitates commercialization, knowledge exchange, and the formation of new entrepreneurial activities.

However, the cluster is also capable of identifying and generating a physical area of application and influence: Within it, ports, major and minor, work as territorial centralities and hinges at the scale of the city

and individual architectural elements. Other poles—including logistic platforms, inland ports, infrastructural exchange hubs, and, in particular, cities linked to these ports—contribute to the production of a complex and constantly evolving relational framework. Based on the work of de Langen (2004), Kocsis recognizes the existence of a port region because “port activities are shared among many municipalities and concentrated not only in port cities. Many times in port cities fewer port activities are found than in cities close to the actual ports” (Kocsis, 2011, p. 53). Understood in this way, the notion of port region complements and supports the idea that the cluster has a physical and spatial impact on territories.

With the aim of affirming renewed attention to the role of space as a strategic tool, the formalization of port clusters introduces the mechanism of “spatial clustering” in the operational territories between land and sea. It also highlights the latent potential of in-between territories that connect ports, motivating the study of the port-cluster landscape, i.e., the spatial product of the port clusterization phenomenon. The notion of port-cluster landscape is better understandable if linked to that of port cityscape, theorized by Hein in her work (2019). According to this definition, space plays a crucial role:

Many contemporary ports are surrounded by high fences and are controlled by special institutions, but their spatial footprint—for example through infrastructure, warehousing, and logistics networks—as well as their environmental impact—for example, air, water, soil or noise pollution—extends far beyond the port’s demarcated borders into neighbouring cities and regions. The result is a port cityscape, a networked space that extends from land to sea, including ships and pipelines, port facilities and warehouses, industrial and logistic structures, headquarters and retail buildings, but also housing and leisure facilities. This port cityscape is administrated, planned, imagined and represented by multiple institutions and rarely as part of a shared vision. (Hein, 2019., p. 4)

According to Notteboom et al. (2022), a port system can be defined as “a system of two or more ports, located in proximity within a given area.” In the literature, various geographical and functional scales have been identified ranging from complete coastlines (e.g., the west coast of North America as one port system) to the notion of a “range” (Vigarié, 1964) and a “multi-port gateway region” (Ducruet, 2009). When one approaches the study of port systems in maritime network analysis, one is confronted with studies that had in common that they considered port development from a strict land-based perspective. This was criticized during the same period by Rimmer (1967), who called for the inclusion of maritime linkages in the study of port systems (Ducruet & Notteboom, 2020).

Other studies by Ducruet and Notteboom (2020) have observed that the definition—and consequently the boundaries—of port systems differ significantly across the academic sphere, often being conflated with concepts such as a coastline, a nation, a region, or a broader maritime area, encompassing seas, basins, or even entire port networks. Additionally, port system analysis has historically focused on small clusters of ports within national borders, reflecting the assumption that port systems are primarily shaped by geographic proximity and political boundaries.

These reflections are aligned with certain guidelines recently issued in national contexts, i.e., Italy, where the clusterization phenomenon is becoming more and more consolidated. The 2017 *Linee Guida per la Redazione dei Piani Regolatori di Sistema Portuale* (Guidelines for the Drafting of the Port System Regulatory Plans) were drawn up to manage these new port systems. They deal with logistics and infrastructure connections but

above all reflect on a new definition of “port.” A definition that recognizes that the scope of port planning may not coincide with the territorial jurisdiction of the Port System Authority (PSA). In some cases, maritime areas owned by the state may fall outside this jurisdiction if deemed non-strategic for port operations. Conversely, some non-state-owned areas may be included, since they are functionally linked to the port.

2.2. Region/Port City Territory

Research by Notteboom and Rodrigue (2005) seeks to contribute to the existing literature by introducing a phase of port regionalization in the evolution of port systems. They stated:

The phase of port regionalization not only expands the *Anyport* model of James Bird (1963). It also extends the existing literature on the spatial development of seaport systems in relation to maritime and hinterland networks. The geographical system would evolve from an initial pattern of scattered, poorly connected ports along the coastline to a main network consisting of corridors between gateway ports and major hinterland centres. (Notteboom & Rodrigue, 2005, p. 3)

Overall, looking into the extensive bibliography about port clusters mainly in economic geography, the port region seems to be a rather descriptive term, lacking clear substance or operational explanatory value. As a result, geographer Ducruet (2009) affirms that the port region remains a multifaceted concept embracing different realities such as the economic area around a port (i.e., the port region *stricto sensu*), the logistics area connecting the port (i.e., the hinterland), and the area in which inter-port relations take place (i.e., façade, range, or system of ports).

Shifting the reasoning to the notion of the port city territory, Hein et al. (2023, p. 22) describe it as “a distinctive type of space that includes a maritime foreland and a terrestrial hinterland, a space where ports have major impact on and co-exist with urban settlements and rural areas.” In their 2023 *Port City Atlas*, which collects 100 maps of port city territories elaborated to serve as foundation for future research and policymaking, the authors point out the reasons for using the term “territory” rather than the term “region” in association with the binomial “port city”:

The port city territory as a whole is not an institutional or statistical entity. On the contrary, it crosses institutional and administrative borders, and is often difficult to recognize due to absence of clear spatial borders and relevant datasets. (To distinguish this concept from administrative language, we opted to not use the term region, as in port city region). (Hein et al., 2023, p. 24)

3. Port Clusterization in Europe

3.1. An Evolving Scenario

Port clusterization involves the administrative consolidation of two or more ports, which may not be located within the same region or country but operate within a shared economic, political, and infrastructural context. Driven by financial and logistical advantages, this model has been implemented in various European settings since the late 20th century. Notable examples include the Copenhagen–Malmö cluster, which has been managed by a single port authority in the Baltic region since 2000, and the 2021 partnership between Paris,

Rouen, and Le Havre (HAROPA Port), a key river and seaport axis that provides Atlantic access to activities along the Seine River. In both instances, the establishment of this new governance framework has set the stage for spatial changes that will unfold over several decades. Other interesting cases can be found in this perspective: the Port of Antwerp-Bruges (Belgium), a limited liability company of public law with the City of Antwerp and the City of Bruges as shareholders, formalized in 2022; the Valenciaport that, since 1992, includes the three state-owned ports of Valencia, Sagunto, and Gandia; and the APBA—Port of Algeciras Bay Authority (ports of Algeciras Bay and Tarifa), which, since the 1990s, is a public organization that belongs to the Ministry of Transport, Mobility and Urban Agenda. Moving outside Europe, the phenomenon concerns, e.g., the area of New South Wales in Australia: The Port Authority of New South Wales is in fact a company owned by the government that acts as harbourmaster in the state's six commercial ports.

In Italy, the concept of port systems was already included in the first port law enacted in 1994. Law No. 84/1994 recognized the port as a system with the potential to impact areas beyond the state-owned land directly connected to maritime traffic. However, it was not until the 2016 Port Reform that the 24 Port Authorities were consolidated into 16 PSAs under Legislative Decree No. 169. Port clusterization in Italy has been also coordinated with the formalization of metropolitan areas in 2014 which eliminated the figure of provinces by merging more cities and territories (Law No. 56/2014). Although the consequences of the two laws are not yet tangible, it is clear that they contribute to introducing new scenarios not only for ports, but also (or above all) for cities involved in these changes.

Governance and planning are intricately linked, particularly at the intersection of city and port. Government structures shape the planning efforts of both public and private entities involved in transforming spaces located at the port-city boundary, where the impact of planning tools is generally less clear (Moretti, 2020). However, the coordination brought about by the clustered model has yet to produce immediate changes in the planning strategies employed by ports. While some clustered ports are exploring ways to organize their activities more effectively and complementarily, in other regions (particularly in Italy), PSAs remain independent, and focused on local projects. Extending this argument, administrative consolidation creates a new dynamic that stretches along the coast and into the hinterland.

3.2. A Spatial Methodology for Designing Port Clusters

The main spatial impacts related to the phenomenon of port clustering are studied employing a space-based methodology articulated in three main research phases, namely “Investigation,” “Crossing,” and “Formulation.” The methodological structure is also displayed in a diagram illustrating the research phases and detailing their activities, tools and results (Figure 1). The results of each phase constitute a “toolkit” of lexical categories (Glossary), maps (Atlas), and strategies (Catalogue) to contribute to the design of contemporary port clusters.

A founding principle lies in the analytical combination between the scientific knowledge brought by academic research and the operational knowledge guaranteed by the active involvement of public institutions, both in Italy and beyond, and international associations capable of strengthening dialogue. As shown in the methodology illustrated in Figure 1, co-design and co-creation activities (workshops, online sessions, seminars, etc.) were used as tools to advance research. The implementation of these activities has been carried out thanks to the support of the network of Italian PSAs—the Association of Italian Ports (Assoporti)—and the Worldwide Network of Port Cities (AIVP).

WP1

INVESTIGATION

[year 1 - months 1/9]

ACTIVITIES

Literature Review (LRev)
Questionnaire Dissemination (QueDiss)
Glossary Survey (GLOSS)

TOOLS

Questionnaire
> to 16 Port System Authorities (IT)
via Assoporti

Indicator System
12 spatial indicators

Archive Research
Inter-disciplinary Literature Review

RESULTS

1st TOOL-KIT COMPONENT
GLOSSARY
new lexical categories

WP2

CROSSING

[year 1/2 - months 9/17]

Interviews Tour (InTour)
Cross-referenced Maps (CROSSMaps)

Interviews
> to 4 EU reference cases
via AIVP

Maps
> within 2 Italian port contexts
(ADSP MAO /ADSP MTS)

2nd TOOL-KIT COMPONENT
ATLAS
multi-level maps

WP3

FORMULATION

[year 2 - months 17/24]

Strategies Setting (STRAs)
Field Trips (FTr)

Design Strategies
translating of 6 Spatial Indicators
into 6 Design Strategies
> in line with the AIVP Agenda 2030

Field Trips
> to 2 Italian port contexts
(ADSP MAO /ADSP MTS)

3rd TOOL-KIT COMPONENT
CATALOGUE
design strategies

Figure 1. Diagram of research methodology. Note: Figure concept and graphic elaboration by Beatrice Moretti.

Through the setting and sharing of a questionnaire and a collaboration with the 16 Italian port systems that represent an early stage of clusterization, the “Investigation” phase records the spatial impacts emerging from the Italian context. As a result, it builds the Indicator System, an evaluation tool consisting of 12 spatial indicators referred to the port cluster dimension. The construction of the Indicator System as a methodological tool comes both from data collected through the literature review and from the discussion triggered with the 16 Italian port systems through the questionnaire. Studying the literature related to the concept of clusters (especially in the geographical field), certain definitions were used in order to decline them in a port spatial context: e.g., the definition by Swann and Prevezer, “clusters are here defined as groups of firms within one industry based in one geographical area” (1996), or Rosenfeld’s definition according to which “a cluster is very simply used to represent concentrations of firms that are able to produce synergy because of their geographical proximity and interdependence, even though their scale of employment may not be pronounced or prominent” (1997). Concepts such as rationalization, inclusiveness, proximity, complementarity, coordination, and concentration were involved to originate the 12 indicators. Further validation of the indicators came via the questionnaire, in the form of co-design and co-creation activities, and allowed for the final tuning. In some cases, the responses resulted in additions of new indicators. For example, when answering the question of what were the main spatial impacts brought in by the port clusterization phenomenon, one of the respondents suggested that clustering has led to the modification of the port skyline and landscape through the updating of the former edges of the sea–land interface due to the new clusterization scenario. This contribution gave rise to the definition of indicator 11 “Visual modification of the port skyline—VisModPortSky.” An additional co-creation exchange was

instrumental in the definition of indicator 9 “Perception/acceptability of the port from/by the port-city territory—PercAcceptPortCTerr”: the concept of perception initially proposed was expanded to the notion of acceptability, to include the role of urban-port communities (WP1 “Investigation”).

The Indicator System is employed as a cross-reference tool in the “Crossing” phase to study the spatial impacts of the port clusterization phenomenon and, according to it, draft multi-level maps able to represent the port cluster’s spatial dimension within two selected Italian port city territories where an early stage of clusterization is noted. The Indicator System is also employed to deepen, through a set of interviews, the clustering status of four international port clusters in which it is possible to detect an advanced stage of clusterization. The two Italian port city territories selected for the mapping are the Port Network Authority of the Eastern Adriatic Sea (Ports of Trieste and Monfalcone) and the Port Network Authority of the North Tyrrhenian Sea (Ports of Livorno, Piombino, Capraia, Portoferraio, and Rio Marina). The four international port clusters are the HAROPA Port in France, the North Sea Port between Belgium and the Netherlands, the Valenciaport, and the APBA—Port of Algeciras Bay Authority, which manages the ports of Algeciras Bay and Tarifa, both in Spain. These selections—both of advanced and preliminary cases—are made based on notions deduced from the previous research phases and collaborations with experts, such as AIVP, which facilitated fruitful exchanges. The mapping activity was carried out through co-design and co-creation sessions with experts (architects, engineers, planners, and GIS specialists) belonging to the two selected PSAs in Italy. As for the questionnaire, the wealth of knowledge and data they provided is an indispensable starting point for building reliable research instruments (WP2 “Crossing”).

In the “Formulation” phase, the spatial impacts already studied and visualized in the maps are translated to develop design strategies. Specifically, 6 of the 12 indicators are further examined according to a logic of higher occurrence, intensity, and frequency of their impact on the territories of the two Italian selected cases. The resulting design strategies aim to be in line with the 10 goals of the AIVP *Agenda 2030* (AIVP, 2018), which were adapted from the UN’s 17 Sustainable Development Goals for the specific context of city–port relations. Contemporary port clusters need to be confronted with the global framework of guidelines and standards already in place to guide their development and projects in specific places. So, the connection pursued with the AIVP *Agenda 2030* is motivated by the aim of validating the research results with current policies in terms of the management and design of urban-port spatial conditions and to facilitate their future exploitation through the drafting of a policy brief (WP3 “Formulation”).

4. Displaying Spatial Impacts Through Multi-level Maps

4.1. Twelve Spatial Indicators

The increased cooperation of neighbouring ports was already a growing trend between 2010 and 2016, which happened either bottom-up, because of cooperation between port managing bodies, or driven by government policy (ESPO, 2022). As recent mergers, the 2022 ESPO report acknowledges the North Sea Port (Ghent, Vlissingen, Terneuzen) unified in 2018, the HAROPA Port (Le Havre, Rouen, Paris) in 2021, and the Port of Antwerp-Bruges (Antwerp, Zeebrugge) in 2022. This list includes also Italy where, since 2016, old port authorities have been replaced with new PSAs to which several ports belong. As a result, the consolidation of port authorities has brought together 62 Italian ports, decreasing the number of governing bodies from 24 to 16.

However, there are differences between the above cases. While in the HAROPA Port case the three ports forming the cluster had already been operating in a merger and complementary logic for decades, in Italy the unification of ports was introduced by central government bodies, with a top-down approach. They are recently established port systems that, for research purposes, are considered an expression of an early stage of clusterization. In fact, as Hein et al. (2023) maintain:

[In Italy] the central government decides on finances, while the PSAs coordinate and plan ports logistics and expansion. Changing the governance system also changed the port city territory, because the reform addressed inefficiencies related to hinterland connections. The 16 PSAs assumed the duties and powers of traditional port authorities, but with a broader geographic scope. (Hein et al., 2023, p. 65)

The mapping activity provides for data collection and elaboration of conceptual maps, generating the Atlas of Maps of the Port-Cluster Landscape. Through the application of the Indicator System, its goal is to visualize the spatial impacts within specific port contexts and to evaluate its purpose from a strategic perspective. Designed as an “evaluation tool,” the Indicator System consists of 12 indicators. Shown in Figure 2, they are as follows:

1. “Degree of sea-land connectivity & geographical links—DegConGeoLks”: level and intensity of physical connections involving areas and artefacts located on the coastal edge between land and sea, including the presence of natural grafts (rivers, canals, basins, etc.) capable of increasing this connectivity.
2. “Infrastructure sharing & rationalization—InfrSharRat”: level and intensity of subdivision and specialization in the operational territories of the different infrastructure systems, on land and at sea, related to the port sector.
3. “Services pooling & optimization—ServPoolOpt”: level and intensity of physical pooling of port services and facilities within the poles and the territories of influence of the cluster.
4. “Functional synergies and operational linkages—FunctSynOperLkg”: presence, level, and intensity of operational interactions between the cluster poles at functional level, e.g., spatial synergies or overlaps between areas with similar uses.
5. “Spatial occupation of the coast—SpatOccCoast”: level and intensity of physical settlement of coastal spaces.
6. “Proximity, inclusiveness, concentration of firms/industries—ProxInclConInd”: level and intensity of cooperation and physical concentration of and between companies carrying out port-related activities.
7. “Coordinated planning & project tools between ports in the cluster—CoordPlanProjTools”: existence and effective application of territorial governance tools at the cluster scale, i.e., plan and project tools capable of collectively involving all ports and territories within the single cluster.
8. “Port-to-city & land-to-sea overlapping—PortCityLandSeaOverl”: existence and level of physical overlaps involving systems and/or services connected to both the port and the city, i.e., spatial systems simultaneously and contextually serving both fronts through the land–sea interface.
9. “Perception/acceptability of the port from/by the port-city territory—PercAcceptPortCTerr”: level and intensity of reception of port infrastructure and operational equipment by the communities of the port cities that make up the cluster, also with a view to the regional scale.
10. “Port-city-territory-interfaces heterogeneity—PortCTerrInterfHet”: level and intensity of functional and spatial variety between systems and artefacts located along the operational boundaries between port, city, and territory, i.e., constitutive differentiation of the interfaces.



Figure 2. The Indicator System: 12 Spatial Indicators. Note: Figure concept and graphic elaboration by Beatrice Moretti.

11. “Visual modification of the port skyline—VisModPortSky”: level and intensity of the transformations that have occurred to the port landscape following the formalization of the cluster, with reference to visual changes concerning the profile and image of ports from the sea.
12. “Dual-function architectures—DualFuncArch”: existence of architectural artefacts housing hybrid operational and civic functions, i.e., buildings with a dual typology and formal character.

The spatial indicators cover a wide range of aspects associated with port clusters and related operational spaces. The main aspects addressed are the morphological conformation, the infrastructural apparatus, and the incidence of port services of the sites, as well as aspects of rationalization, optimization, and sharing of resources and equipment between the ports of the cluster.

They deal with planning and project aspects by questioning to what extent and how the cluster ports develop coordinated transformation tools. Aspects of perception and visibility of the port from the urban-port territory are also assessed.

With a shift in scale, some of the indicators investigate the degree to which the port’s skyline has changed following the introduction of the cluster and the presence of dual-function architectures, products of the heterogeneity and the complexity of the city–port interface.

4.2. Building an Incomplete Atlas

The “spatial stretching” affecting contemporary ports underscores not only the limitations of current governance and design frameworks but also the lack of visual representations that simultaneously capture these territories. The clusterization of ports demonstrates the rise of a broad phenomenology of new spaces (Moretti, 2023) that current interpretations only partially reproduce and which cannot be presumed to be the exclusive product of a few local specificities, as often observed in the literature on port cities.

Therefore, the Atlas of Maps of the Port-Cluster Landscape has been elaborated to apply and visualize the spatial impacts, defined in the Indicator System, in concrete contexts and evaluate their purpose from a strategic perspective. Drawn up at different scales according to the specificities of each port cluster but referring to the same levels of analysis (the “Cluster Level” and the “Port City Territory Level”), the multi-level maps assume and display the spatial impacts to be as credible as possible.

As for the questionnaire, the mapping activities were set up through co-design and co-creation sessions with experts belonging to the two selected PSAs in Italy. During the sessions, a draft of the map was shared to be used as a basis for discussion, each indicator was evaluated, and its impact was located on the cartography; to draft it more accurately, data and tables from the *Documento di Programmazione Strategica di Sistema* (DPSS) and from the official GIS platforms of the PSAs were used, where available. After a graphic post-production, the maps were shared again with the PSAs for further evaluation.

The choice of a map that descends from a collaborative path is closely related to the type of map itself. Referring to the work of Wall, space “is always under construction” and, consequently, cannot be represented with “traditional top-down architectural techniques in which designs and representations attempt to fix time and complete space” (2017, p. 110). Thus, the idea of constructing “incomplete maps,” as

Wall suggests, aspires to generate tools that are open-ended to change, namely visuals to explore the evolving landscapes of the cluster.

According to this, the maps shown in Figures 3, 4, and 5 possess a conceptual slant and synthesize two notions of narrative. They read the port-cluster landscape through the filter of the 12 indicators to detect the presence, recurrence, and positioning of spatial impacts; this narrative is structured by the main author of the map. At the same time, they review the port-cluster landscape through the exchanges conducted with experts from the PSAs involved; in this process, the maps become collective and co-authored.

Far from geospatial mapping, this approach emphasizes how such maps result from a creative process of assembling, analysing, reworking, representing, and, ultimately, designing future landscapes. Built in a collaborative dialogue between academic researchers and policymakers, these maps are indetermined: they have inclusive potential and serve as “projective devices” (Wall, 2017, p. 114).

4.3. Mapping the Trieste and Monfalcone Port Cluster: A Preview

The Atlas of Maps of the Port-Cluster Landscape is articulated in seven maps encompassing the entire port system territory. To facilitate visualization, each indicator is assigned a specific key colour and/or pattern visible in the map legend. Each indicator is assigned a short acronym that corresponds to the legend, as shown in Figure 2. To provide an example, the article presents the three maps of the ports of Trieste and Monfalcone displayed at the Cluster Level (Figure 3) and at the Port City Territory Level (Figures 4 and 5). The framing of each map considers the methodological approach of the *Port City Atlas* of Hein et al. (2023), while basing it on the official perimeter of the PSA of the Eastern Adriatic Sea.

In the case of the port of Trieste at the Port City Territory Level, the spatial impacts are visualized in a vast territory that stretches between sea and land, involving both the system of breakwaters and the hinterland, highlighting some key junctions where the cluster’s impact is most evident. These include the Intermodal Terminal of Trieste–Ferneti, which marks the traffic channel to Slovenia, and the Innoway Trieste site, recently reindustrialized for the production of high-tech railway wagons. The mapping work also collects the main forecasts of the Strategic System Planning Document (Documento di Pianificazione Strategica di Sistema, DPSS), which also involves the port of Monfalcone, in terms of new commercial terminals. It also shows the impact of the clustered port in terms of urban perception: in this context, the steep morphology marking the Italy–Slovenia national border also defines a new visual image of the port skyline. The map taken as an example here is neither intended to return the functional differentiation of the port area, nor does it necessarily refer to the port’s administrative boundary. As illustrated, the map also addresses the area linking the cluster’s key nodes, where each entity exists not only to share costs but also to shape a plural vision of the port within the broader integrated coastal development.

The key objectives of this mapping activity are the development of a mapping without borders (other than those of the page) and the simultaneous visualization of spatial impacts on the territory, while considering their inevitable stratification and superimposition. In line with the theoretical notion of cluster, the maps attempt to represent its impacts as a “horizontal phenomenon,” thus characterized by relational dimensions and spatial articulations. Whatever their deficiencies—as already discussed in the previous paragraph regarding their incompleteness—these maps try to represent the “cluster extension.”

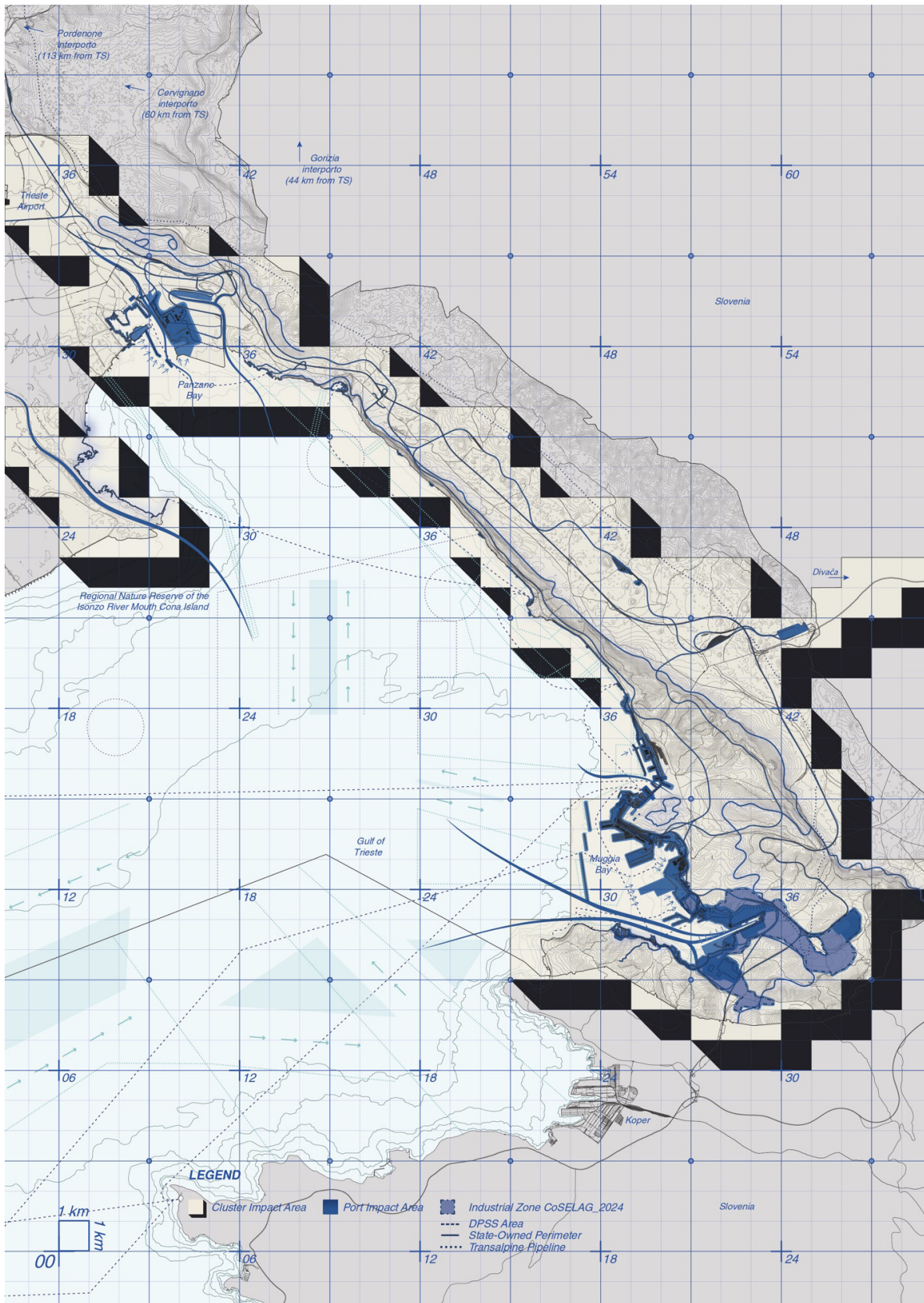


Figure 3. Atlas of Maps of the Port-Cluster Landscape, Cluster Level: Trieste and Monfalcone. Note: Figure concept and graphic elaboration by Giulia Ansaldi and Beatrice Moretti.

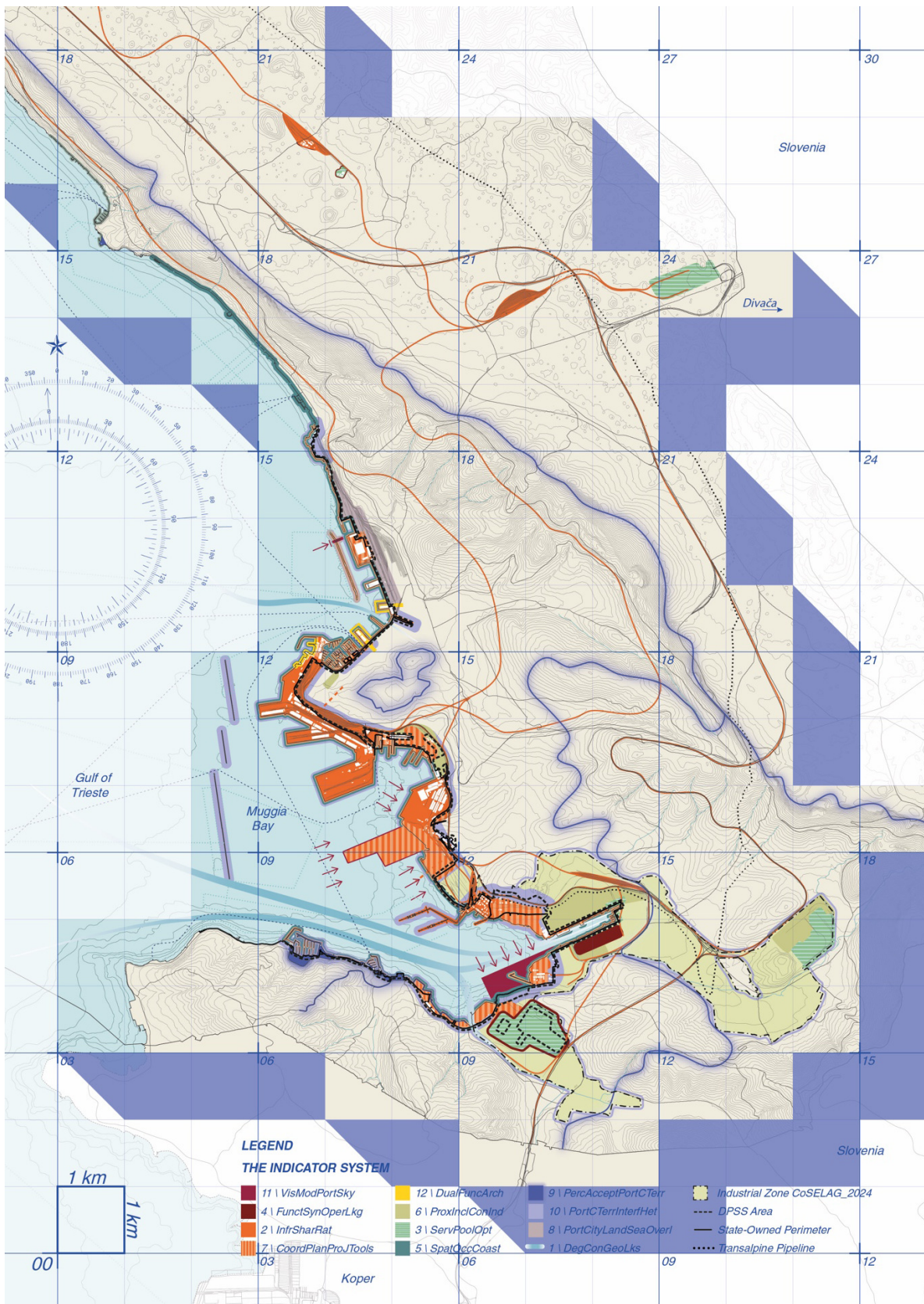


Figure 4. Atlas of Maps of the Port-Cluster Landscape, Port City Territory Level: Trieste. Note: Figure concept and graphic elaboration by Giulia Analdi and Beatrice Moretti.

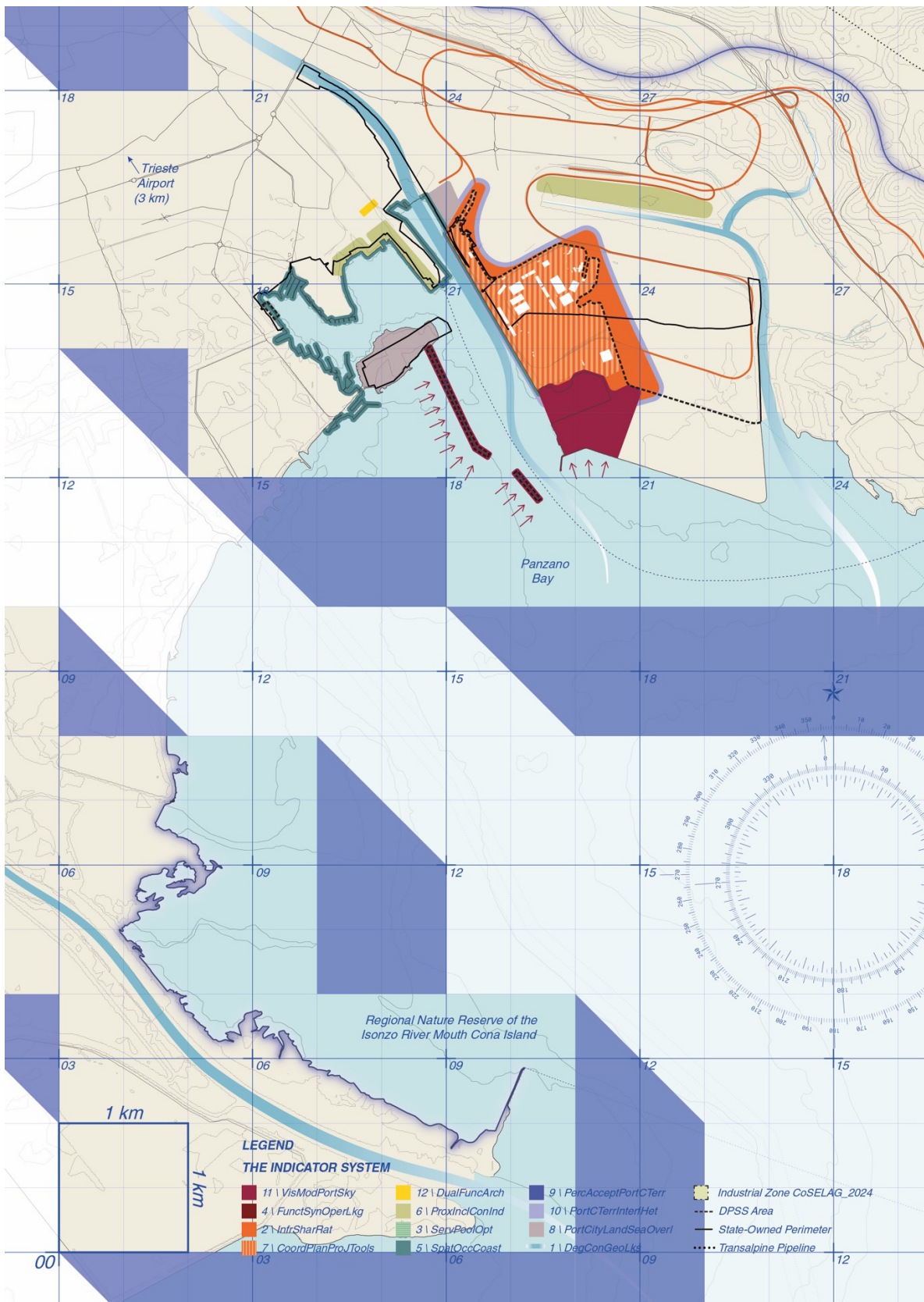


Figure 5. Atlas of Maps of the Port-Cluster Landscape, Port City Territory Level: Monfalcone. Note: Figure concept and graphic elaboration by Giulia Ansaldi and Beatrice Moretti.

The two maps developed at the Port City Territory Level are complemented by an introductory Cluster Level map that shows together the spatial impacts related to the ports of Trieste and Monfalcone, as well as framing the port of Koper in Slovenia.

The same methodological approach is in the process of being applied in the PSA of the North Tyrrhenian Sea with an overall map showing the spatial impacts of the cluster made up of the five ports (Cluster Level) and four individual maps displaying the spatial impacts in Livorno, Piombino, Capraia, Portoferraio, and Rio Marina (Port City Territory Level).

By further developing this methodology, currently tested on two Italian port city territories, it is believed that the characteristics of the port-cluster landscape will emerge more clearly, highlighting the need for new indicators to record specific impacts, or the possibility of merging, overlapping, or eliminating some of those already defined.

5. Conclusion: Embracing the Polycentricity and Polymorphism of Contemporary Port Spatiality

Port spatiality is constantly evolving. This has been the case since the dawn of ports, as their structure adapts and evolves in accordance with the ways goods are exchanged and managed between ports. If, with the growth of the logistics sector in recent decades, the role of territories has reduced its significance due to the digitalization/dematerialization of traffic, it seems that ongoing processes—such as port clusterization—can bring the spatiality of ports back to the centre.

From the application of the spatial indicators and the elaboration of the Atlas, we can preliminarily state that the port-cluster landscape is a polycentric, heterogeneous, and often disjointed set of spaces. A very extended one which is subject to the control of multiple public actors and conditioned by the funding and projects of private actors. A set of spaces in constant reconfiguration and negotiation in which partnerships between ports are rapidly multiplying: “Not only do ports increasingly organize in clusters or merge with other port managing bodies, strategic partnerships on specific topics with other seaports either at national or international level are also taken up” (ESPO, 2022, p. 19).

By acknowledging this particular type of landscape, the idea of the city–port interface will be expanded and spatial connotations will be attributed to traditional definitions of the cluster that currently lack them. With the concept of port-cluster landscape, the port cluster will have a (changeable) perimeter, its extent will be measurable (also in volumetric terms thanks to the indicators that consider the port geography and skyline), and the spatial relations between the mobility infrastructures that feed the cluster, the geographical arteries on which it hinges, and the built environment that populates the urban-port hinterland will be comprehensible. From this perspective, we can see correspondences between the concept of port-cluster landscape and the definition of “technical lands” (Galison, 2017; Nesbit & Waldheim, 2022). This further emphasizes the debate on the relationship between technical components and the spectrum of spatiality they can produce.

First design recommendations emerge regarding the 12 spatial indicators. As illustrated in the methodology, indicators will be translated into corresponding design strategies to form a Catalogue to guide the future project of port clusters. This translation is based on the idea that “urban design is in substance a normative activity

that often makes use of principles to transfer knowledge of a given urban phenomenon to the design process” (Forgaci, 2018, p. 181). Moreover, the resulting design strategies will be linked with the goals of the AIVP *Agenda 2030*: this step will be crucial to transform the results of scientific research into exploitation tools for planning. Indicators 5 “Spatial occupation of the coast” and 8 “Port-to-city & land-to-sea overlapping,” e.g., can provide valid insights into the implementation of the AIVP goal of “promoting the architectural and landscape integration of port facilities” (Goal 08.4 “Port City Interface”; AIVP, 2018, p. 25). By pursuing the AIVP Goal 04.05 of “adopting a land management policy that strikes a balance between urban uses and the active port, especially on the waterfront” (AIVP, 2018, p. 17), we can exploit the insights derived from indicator 7 “Coordinated planning & project tools between ports in the cluster,” 9 “Perception/acceptability of the port from/by the port-city territory,” and 10 “Port-city-territory-interfaces heterogeneity.”

In terms of strengths and weaknesses, research will need, in future developments, to test its methodology on a wider selection of port clusters. A broader application will make the research more reliable and flexible. The ambition to build a study based on dialogues with the PSAs, on one hand, generates a complex system of exchanges between institutions and academia based on a shared language and perspectives that often clash with their respective areas of expertise. On the other hand, this system can lead to further collaborations involving the academic field and that of territorial administration and transition.

As AIVP states in the *Agenda 2030* for sustainable port cities, “port cities are today very exposed to the perverse effects of growth. In fact, in the short term, the consequences of climate change threaten their very existence” (AIVP, 2018, p. 3). In view of this, the research claims the role of port cities as indispensable players in sustainable development, by representing one of the first scientific contributions to the design of port clusters and their spatial configurations. Moreover, to position ports as key elements in the development of future living and working environments, this research aligns with the reimagining of the built environment, as proposed by Christian Schmid: “Existing urban forms are dissolving and polymorphous urban regions are taking shape. Extremely heterogeneous in structure, they include old city centres as well as formerly peripheral areas” (Schmid, 2014, p. 204). To understand the new built forms—including clustered ones—research must move beyond analysing individual cities shaped predominantly by ideal-typical models. Instead, it should embrace the polycentric and polymorphic nature of contemporary spaces, while also considering the broader impacts of global urbanization and its varied regional and local patterns.

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Conflict of Interests

The author declares no conflict of interests.

Data Availability

The data associated with this research are available in the official PULSE research databases held by the Principal Investigator and by the Host Institution.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

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