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Investigate past polluting activities on public health and land uses

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ABSTRACT

Port regions are hubs connecting a nation and its hinterland to the rest of the world. Port cities' authorities and actors have always dealt with pressures and compromises in the sharing of space between agriculture, tourism, industry, and urban developments. The limited availability of land created conflicting uses over time especially when industrial sites disappear from the built environment to leave a polluted soil and water. The current literature discusses in detail changes in industrial land use, pollution of industries, and urban sanitary issues. Yet, only a few studies investigate the consequences of past industrial and urban developments on the health of citizens. This paper thus asks: How have authorities considered historical industrial activities in spatial planning policies and what are their consequences on public health in port cities? Of all pollutants, oil appears to be the widest spread with long term risks to human health. Oil industrial development in the port city of Dunkirk in the north of France can demonstrate this influence of past land uses. The objective is to highlight the impacts of past polluting activities over current populations' health in port city regions and the potential consequences of historically contaminated sites on public health.

1. Introduction

Pollution from past industrial activities can have lasting effects on the health of populations as public authorities of the past disregarded the quality of the soil and the water in the transformation of industrial sites. The oil industry which started in the 1860s, in combination with the port city of Dunkirk, in the north of France, illustrates the extent of the problem. With the closure of oil refineries in Dunkirk, oil spread beyond the former borders of petroleum sites. Industries formerly on the periphery of the city became either part of the urban tissue or vanished with the demographic and urban growth, and the continuous extension of the port area (Fig. 3). Thus, in place of oil refineries or storage areas, one can now find houses, green spaces, shops, and schools (Ministère de la Transition Ecologique, n.d.) (Fig. 1).

Industrial activities polluted the environment through disasters, changes in land uses, and the location of oil sites nearby water networks. In time, oil infiltrated the soil, reached rivers, canals, and the underground water network, and spread beyond the administrative borders of the industrial site.

Previous investigations of the port city of Dunkirk demonstrated that borders dividing industrial and residential areas were dangerous and permeable (Hauser et al., 2021). Moreover, numerous oil sites opened and shut down in the French port city, but complete information from official records of polluted sites is missing (Hauser, 2020a, 2020b). Private and public actors cleaned the soils of only three of the fourteen identified areas. This practice has led to a situation where many inhabitants are living on polluted lands that was formerly stocking or transforming petroleum.

Scholars in a recent webinar (June 17, 2021) held jointly by the European branch of the World Health Organization (WHO) and the Union for the Mediterranean (UfM) underlined the insufficient assessment of port activities' impacts on public health in port cities (Hauser, 2021). Specifically, the webinar revealed a gap in the literature on the impacts of port activities on the health of inhabitants. Drawing on these discussions, this brief highlights this gap by mapping former sites, water networks, and analyzing literature and a health report from a public institution. This study contributes to the existing literature by bridging public health to the detection of pollution from oil sites in port cities as the results are transferable to other oil-related port cities around the world. The findings from past industrial developments are important for the efficient and sustainable planning of port cities. They will help to tackle the hampering and lasting influence of oil and industrial activities.

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2. Literature

Many studies on the revitalization of former industrial areas exist but are focusing on contemporary industrial sites (Kitheka et al., 2021; Li et al., 2018; Tempel, 2012). The literature mainly focuses on existing or modern industrial infrastructure from the 1980s or 1990s onwards, that either disappeared and left brownfields or closed with their facilities still standing. Despite the numerous oil-related incidents globally, the number of investigations on the consequences of industrial disasters and activities on human health remains low (Eklund et al., 2019). Yet, examining the detrimental effects of petroleum pollution on human health could improve the management of pollution. This is true not only for past and current oil industrial sites but also for other types of industries around the world (Sam et al., 2017).

Fires, explosions, or leaks of petroleum (Yanxun et al., 2011) with the presence of a nearby surface or underground water participate in spreading the pollution around oil sites over tens to hundreds of meters horizontally (Alloway, 1996; Okandan et al., 2001). This is because movement is minimized in freshwater environments and pollutants linked to oil can remain for a long period, interact with sediments and plants, and pollute the entire ecosystem (Arockiaraj & Kankara, 2019; United States Environmental Protection Agency Office of Emergency Remedial Response & United States Environmental Protection Agency Emergency Response Division, 1993).

Studies found oil-related pollutants beyond the maximum contaminant levels recommended by international organizations in water samples where no oil activities could be found within a 10 km perimeter in active oil regions (Ejike et al., 2017). The persistence of some toxic elements of petroleum in the soil at historical petroleum sites reveals again the lasting threat that such activities can pose on populations (Herman et al., 2020). The presence and accumulation of hydrocarbon components can lead to neurological and carcinogenic issues (Borowik et al., 2019), as well as liver, blood, kidney, and weight problems (Hartley & Englande, 1992). Therefore, this phenomenon can last over a long period of time and needs careful monitoring and investigation (Duffy, Peake, & Mohtadi, 1980).

The short sampling of the literature notes a missing link between industrial activities, pollution, and health issues, especially in port cities. The search for the combination of keywords of health AND “port cities” in Scopus database (1978–2021) yielded 131 papers. The topic receives little attention compared to the 129.336 documents emerging from the search (health AND cities) within the same database. Out of these 131 documents, the term “health” is mentioned the most in the abstracts of 91 studies, whereas only 10 publications mention the term “oil”. Meanwhile, the abstracts of only 11 papers refer to “industry.” Only 4 of the reviewed abstracts mentioning “oil” are also referring to “pollution”, whereas only one cites both “industry” and “pollution”. When searching the term “history” with the same method, it appears in 12 documents, and never in combination with either “oil” or “industry” (Fig. 2). This depicts a further lack in adopting historical analysis when investigating historical industrial developments and their contemporary consequences.

Fig. 1. Comparative pictures between areas of Dunkirk in 1936 and in 2017 to illustrate the evolution of industrial activities on the left with the British Petroleum refinery, and the change in land use and the urban densification around the former trystram refinery, the first refinery of Dunkirk. Images created with ArcGIS using pictures from the “Institut National de lInformation Géographique et Forestière”.

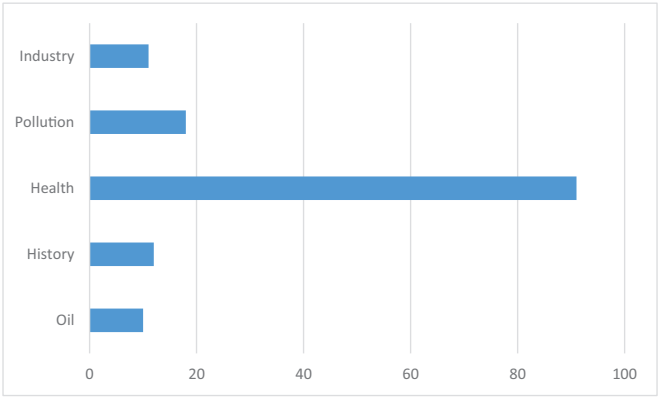

Fig. 2. Use of words in the abstracts of the 131 papers on health and port cities from Scopus database.

3. Data and methods

This brief is part of a broader research on the case of Dunkirk and its oil history (Hauser, 2020a, 2020b; Hauser et al., 2021). The identification and localization of lost oil sites in the French port city relied on the study of archival documents such as maps, plans, letters, and official permits from both city and provincial archives. These documents revealed past planning practices and pollutions along with an online database of aerial pictures of the past (Institut National de l'Information Géographique et Forestière), a detailed listing of French industrial sites (Géorisques), and the literature on the province and city's industrial activity (Amphoux, 1953; Hachez-Leroy, 2014; Thelliez, 1957).

The overlapping of various archival sources and materials by using ArcGIS software (Aktürk & Hauser, 2021) allows the creation of a map illustrating the sanitary challenge of industrial port cities. The map demonstrates the extent that oil activities' pollution can have on the port city by showing the link that exists between oil sites and water. It also shows that a majority of oil sites are located nearby a wide and interconnected water network, which transports oil contamination to the entire port city region (Fig. 3).

Building on the findings of the map, health statistics and a report from the regional health agency (ARS or "Agence Régionale de la Santé des Hauts de France") are analyzed to link the health of inhabitants to past industrial activities. Data of this public institution reveal the prevalence of deaths by cancer and the poor sanitary situation of the region/province as opposed to the rest of the country (Agence régionale de santé des Hauts-de-France, 2017). More local statistics at the municipal level proved difficult to obtain, though the report sometimes specifically refers to the metropolitan area of Dunkirk. Thus, data cannot be directly linked to the long and predominant oil history of the city, but rather to the general industrial development and the socio-economic situation of the entire province. This missing piece of information calls for attention to specific health studies and data on the overall health situation in port cities with active industrial activities.

This overlapping of historical data and sources to explain the spatial development of Dunkirk in line with the oil industry is transferable to other port regions. Studies using such historical materials showed that the growth of Rotterdam as an oil hub and the early oil history of Philadelphia followed a similar pattern as the one discussed in this paper (Hein, 2018). Industrial sites first settled near cities and along water networks. Thus, the objective of this paper is for authorities of industrial port cities and researchers across the globe to consider the extent of this widespread, and yet to investigate, sanitary issue.

4. A complex sanitary evaluation

Depicting the sanitary situation of the metropolitan area of Dunkirk is difficult for two reasons. First, the data available on the health of citizens from the 2017 report of the ARS compares the regional scale with the rest of the country. When the report dives into the city scale, like with Dunkirk, it is to highlight a much higher or lower average than others. Second, the northern region of France, the "Hauts-de-France", has always been an industrial place (mining, textile, steel) with poor socio-economic indicators. The report refers to it in the health section explaining that in the region "with both men and women, mortality is 20% higher than national values. Hauts-de-France has by far the strongest mortality in all hexagonal regions" (hexagonal is a common term used to refer to France through its hexagon shape) (Agence régionale de santé des Hauts-de-France, 2017). This statistical report considers a wide range of diseases and externalities that led to citizens' death. It further indicates that the statistical gap between this industrial region and the country is even wider in urban areas of at least 100.000 inhabitants like Dunkirk (+28% for men and +25% for women). The

Fig. 3. Map of Dunkirk showing the location of oil sites known and discovered during the research in parallel with the urban expansion and water network of the city. Numbers show two of the oldest refineries of the city: 1. Refinery of Trystram, built in 1861; 2. Refinery of Clère-Boilet, built in 1874. Source: Stephan Hauser using ArcGIS and archival maps of Dunkirk from Centre de la Mémoire Urbaine d'Agglomération.

excess mortality of people below 65 years old in the region is even greater compared to the rest of the country in these same urban areas, with a difference of +40% for men and +30% for women.

In terms of data for death by cancers, the region has an average 18% higher than the rest of the country. The northern territories of the region, Dunkirk's area included, are among the areas with the worst statistics for cancer mortality, with a +20% death rate compared to the national average. Even though many externalities can affect the health of populations, the bad sanitary situation of the region with the rest of the country is pointing at the influence of industrial activities on health.

There is, in the report of the health agency, no link made between industrial activities and the poor sanitary situation of the region. The authors rather emphasize socio-economic factors (employment, education, income) and data linked to the healthcare infrastructure in the region within the report, without making any direct causal link. Words linked to "pollution" or "industry" also never appear in the report, and "contamination" is only used when talking about AIDS (Acquired immunodeficiency syndrome). The consequences of industrial activities, past, and present, on the health of the region's population, are not addressed in the report by the health agency. Yet, indicators highlight the territories of the region in which industrial activities concentrated throughout time.

In recent industrial disasters like the one of Lubrizol in Rouen, France, in 2019, the analysis of historical developmentsand statistics on pollution justified a deadly normalcy (Hauser, 2020a; Izoard & Blanc, 2020; Littlejohn, 2020). When the first reports on this catastrophe emerged a few months later, the inspecting company could not prove the polluting impact of the fire. The pollution levels in territories non-affected by the smoke revealed similar levels of contamination to those affected. The authors of the report associated such levels with the long history of industrial activities of the region (Service régional et départemental de la communication interministérielle, 2019, October 1). A different report from another province potentially affected also mentioned an absence of "severe toxicity" (Service régional de la communication interministérielle, 2019, September 3). While such words ignore the potential delay of pollution and the link with industrial activity, an absence of severe toxicity means no toxicity at all (Bécot, 2019).

5. Conclusion: a gap to fill in spatial planning and public health

This paper emphasizes the urgent need for investigation of spatial planning, public health, and industrial pollution around and within port cities through the analysis of mapping, literature, and local report in the city of Dunkirk. We acknowledge that there are limitations relating to the geological and sanitary characteristics of each port cities. But the inclusion of the missing data can give us a better understanding of the consequences of pollution on public health in port cities. Though the study takes Dunkirk as an example, many other port cities around the world face similar developments. The long petroleum history of port cities like Philadelphia in the U.S, or Rotterdam in the Netherlands, illustrates the transferability of this problem.

The analysis of historical developments and of health indicators points towards the responsibility of industrial activities on the bas sanitary situation of the region. Yet, data on the health of local populations in former or actual industrial places is necessary to understand the effects of soil, air, and water pollution on health and the environment. It is only through such a thorough assessment that public authorities can implement coherent spatial and urban planning as well as public health policies. There is a need for more data on the condition of the soil and the underground water around past industrial sites. There are technical and quantitative assessments of oil pollutants and their effects, but not based on an on-site analysis of their effects and dispersion. Besides, current research from the authors, yet to be published, tend to demonstrate the transferability of the issues and method discussed in this paper, and linked to water. Authorities of cities with a long oil history, such as Daqing or Shanghai in China, will likely face similar spatial and health challenges. Monitoring the sites and disasters from past to present is important before the transformation of these sites into residential areas. The location of former industrial activities may help in the identification of hazard zones for public authorities to efficiently plan the land use of urban areas. This would clarify the moving and three-dimensional borders of oil sites, improve the management of industrial pollution and the sanitary situation of industrial port cities.

The knowledge of past pollution and its handling would help reduce the gap between national health indicators and regional ones. To create better public health policies, there is a need for interdisciplinary research to take into account historical, industrial, and public health fields, as well as town planning policies. The sanitary and environmental actions needed to tackle past and current industrial pollution can, thus, find solutions in the past.

These actions also require political leadership and initiative to improve the regulatory system around industrial sites and correct the sanitary situation in industrial regions (Jacobson, 2001). However, to support local initiative more studies are needed on the local scale linking past and present industrial activities to health consequences.

CRediT authorship contribution statement

Stephan J. Hauser: Writing – original draft, Conceptualization, Methodology, Software. **Gül Aktürk:** Writing – review & editing.

Declaration of competing interest

We have no conflicts of interest to disclose. The research of the first author supporting this paper was partially funded by Antea Group and the Learning Center Ville Durable of Dunkirk.

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