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An Analysis on the Atmospheric Effects During the COVID-19 Pandemic: A Ro-Ro Port Example

COVID-19 Pandemisi Sırasındaki Atmosferik EtkilerÜzerine Bir Analiz: Bir Ro-Ro Limanı Örneği

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ABSTRACT

One of the most difficult issues that the world is currently facing is the pollution caused by greenhouse gases (GHG), which is caused by the transportation industry. All of the international transportation organizations, such as the International Maritime Organization (IMO), the International Civil Aviation Organization (ICAO), and others, have implemented climate change mitigation and adaptation measures. After that obliged the shipping industry to take particular measures after the 1st of January 2020, the International Maritime Organization (IMO) laid out a plan and provided an initial strategy for reducing GHGs in 2018. Emissions caused by humans are a well-established contributor to both the progression of climate change on a global scale and the deterioration of public health. It is an inescapable fact that ports, which serve as one of the touchpoints between different modes of maritime transportation, will also be impacted by these emissions. At Ro-Ro ports, the presence of air pollution is caused by anthropogenic emissions that are produced when ship generators are used in the process of handling goods. Because of this, it is essential to investigate the movements of ships in Ro-Ro ports as well as the quantity of fuel and its features that are consumed by the generators utilized in these ships. Ship movements of a Ro-Ro port that is operational in the Tuzla administrative port region were obtained by using the data from 19 distinct ships' hotelling times by day at the quays in 2019 and 2020. At 2019 and 2020, ship movements in the relevant port were analyzed, and data regarding the length of time that vessels spent at the quays was collected. The data on fuel usage for these ships was used in conjunction with an estimating model that was presented by the European Environment Agency (EEA) in its Air Pollutant Emission Inventory Guidebook. In this study, comparisons were made between ship emissions in different years at the berths of a Ro-Ro port.

Keywords: Maritime, Atmospheric Effect, Ro-Ro Port.

ÖZ

Dünyanın şu anda karşı karşıya olduğu en zor sorunlardan biri, ulaşım endüstrisinin neden olduğu sera gazlarının (GHG) neden olduğu kirliliktir. Uluslararası Denizcilik Örgütü (IMO), Uluslararası Sivil Havacılık Örgütü (ICAO) ve diğer tüm uluslararası taşımacılık örgütleri, iklim değişikliğini azaltma ve uyum önlemlerini uygulamaktadır. 1 Ocak 2020'den sonra denizcilik endüstrisini belirli önlemler almaya mecbur bırakan Uluslararası Denizcilik Örgütü (IMO), 2018'de sera gazlarını azaltmak için bir plan hazırlamış ve bir başlangıç stratejisi sağlamıştır. İnsanların neden olduğu emisyonlar, hem iklim değişikliğinin küresel ölçekte ilerlemesine hem de halk sağlığının bozulmasına köklü bir katkıda bulunmaktadır. Farklı deniz taşımacılığı modları arasında temas noktalarından biri olan limanların da bu emisyonlardan etkileneceği kaçınılmaz bir gerçektir. Ro-Ro limanlarında, hava kirliliğinin varlığı, malların taşınması sürecinde gemi jeneratörleri kullanıldığında üretilen antropojenik emisyonlardan kaynaklanmaktadır. Bu nedenle Ro-Ro limanlarındaki gemilerin hareketlerinin ve bu gemilerde kullanılan jeneratörlerin tükettiği yakıt miktarı ve özelliklerinin araştırılması gerekmektedir. Tuzla idari liman bölgesinde faaliyette olan bir Ro-Ro limanının gemi hareketleri, 2019 ve 2020 yıllarında 19 ayrı geminin rıhtımlarda günlük konaklama süreleri verileri kullanılarak elde edilmiştir. 2019 ve 2020 yıllarında ilgili limandaki gemi hareketleri analiz edilerek, gemilerin rıhtımlarda geçirdikleri sürelere ilişkin veriler toplanmıştır. Bu gemiler için yakıt kullanımına ilişkin veriler, Avrupa Çevre Ajansı (AÇA) tarafından Hava Kirletici Emisyon Envanteri Kılavuzunda sunulan bir tahmin modeli ile birlikte değerlendirilmiştir. Bu çalışmada bir Ro-Ro limanı rıhtımlarındaki farklı yıllardaki gemi emisyonları arasında karşılaştırmalar yapılmıştır.

Anahtar Kelimeler: Stratejik Denizcilik, Atmosferik Etki, Ro-Ro Limanı

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1. INTRODUCTION

Ports are junction points of different transportation modes connecting international and domestic markets. This propriety of ports makes them home to industrial clusters and thus high emission zones. It is recognised that auxiliary marine engines powering hotelling, mooring and unmooring operations of ships are accounted for a considerably big part of port emissions. Exhaust gases and particles emitted by marine engines are considered to be highly harmful for human health and environment, therefore reducing emissions has been at the top of the International Maritime Organization's (IMO) agenda.

Istanbul with 15,4 million habitants is one of the most congested European cities where air and marine pollution is an increasing threat to economy and public health. Ports are very close to residential spaces and densely populated neighbourhoods. Mucilage events and foul-smell observed in several coastal districts frequently make news by invoking public backlash.

Moreover, Istanbul's urban expansion towards the neighbouring cities fuelled by its relatively higher rates of economic growth and waves of rural exodus has meant a significant increase in the port activity in Northern Marmara making pollution the problem of a wider region. Hence, reducing the port emissions in Istanbul and in the wider Marmara Region is becoming one of the prominent environmental issues which is to be tackled by the Turkish national and local authorities.

In this paper, ship emissions at the quay of an international Ro-Ro port located in Tuzla, Istanbul were compared according to years. Firstly, previous work on port emissions and possible solutions were reviewed and measures to reduce shipping emissions assessed. Then, methodology explained and the data was analysed. In the final section, conclusions summarized.

2. LITERATURE REVIEW

According to IMO estimates, maritime emissions accounted for 2,89% of global anthropogenic emissions in 2018 (IMO, 2020), and is expected to increase its share significantly over the next 30 years, although a decline related to COVID-19 is likely to be recorded in 2020 and 2021 (IMO, 2020). The maritime transport sector is estimated to be responsible of almost one fourth of all SOx and NOx emissions in 2018 as a proportion of EU emissions from all industries (EU, 2021).

The International Council for Clean Transport (ICCT) has recognized that the majority of ship emissions occur in seas where ships are dependent on their main engines in the face of heavy seas and severe weather conditions. (Olmer, et al., 2017).

The cruising speed of a ship approaching port decreases, reducing fuel consumption and carbon emissions. At the quay, the main engines are shut down, but the auxiliary engines that power the handling operations continue to run and emit pollutants such as, particulate matter (PM), nitrous oxides (NOx), volatile organic compounds (VOC) and sulphur oxides (SOx) emissions which are main contributors to acidification and eutrophication.

Emissions from a single ship can be relatively higher during the navigation, but ports are places where pollutants are concentrated and have serious environmental and public health impacts threatening densely populated coastal cities. While greenhouse gas (GHG) emissions from ships are associated with global warming, research shows that exhaust gases and particles emitted from marine engines are closely linked to premature deaths, cardiovascular and respiratory diseases (Anenberg, et al., 2019).

One of the most important measures addressing the ship emissions in ports is the "IMO 2020" sulphur cap which decreases the sulphur limitation of fuel oils from 3.5% to 0.5% outside emission control areas (ECA) and to 0.1% in ECAs. Use of low sulphur marine diesel oil (MDO) instead of heavy fuel oil (HFO) is shown to reduce PM and SOx emissions significantly (Shen and Li, 2020), thus the sulphur cap is considered to be an important step to achieve emissions reduction targets of the industry (Shen, et al., 2020). However, Sofiev et al. (2018) predicted that even if low sulphur regulations were in place, ship emissions would still be responsible for approximately 6.4 million childhood asthma cases and approximately 250000 deaths per year (Sofiev, et al., 2018). There have been also studies to develop spatial modelling frameworks to understand the shipping traffic-based emission behaviour for habitat of the certain areas (Wang, et al., 2007; Hadipour, et al., 2021).

In addition to the negative impact of ship-borne air pollution on human health, there are also external costs such as loss of yield and material damage in agricultural products. Considering the health spending and the burden placed on the social security system, it is thought that ship emissions will have an even more significant annual cost. This external cost calculation concept is explained in detail in Jugović et al (2018) (Jugovic, et al., 2018). For a comprehensive review of the literature on quantification and monetization of adverse impacts from human emissions, the reader can refer to Tichavska et al (2017) (Tichavska, et al., 2017).

Increasing external costs with ship sizes and maritime trade make ship emissions at ports a major concern for local and national authorities. Consequently, over the last twenty years, international bodies have been steadily increasing their efforts to decarbonise the industry. Kotrikla et al. (2019) argue that the European Union lacks a comprehensive legal framework regarding pollution caused by ships, yet IMO conventions and national laws of the member states are there to play a complementary role (Kotrikla, 2019). In addition, ports are expected to play an important role in decarbonisation of maritime transport by promoting green technologies and the use of environmentally friendly fuels by ships, thereby promoting the reduction of CO2 emissions on the high seas (COGEA, 2017). Zhu et al. (2017) discussed the importance of encouraging shipping companies to invest in PM emission reduction technologies by introducing market-based measures such as preferential taxation and green credits to reduce pollution in ports and offshore (Zhu, et al., 2017).

However, while green incentive schemes implemented by terminals and port authorities can partially reduce ship-to-port emissions by promoting voluntary speed reduction (VSR) and low-sulphur fuels, some argue that it is possible to reduce emissions more radically by combining renewable energy with onshore power supply (OPS). Using OPS, also known as "cold ironing" (CI), a docked ship can turn off auxiliary engines and use electricity from an onshore source to power its lighting, cargo handling, and other electronic equipment and machinery. Recent research shows that providing even a part of the energy demand of the ship with renewable sources during the hotelling at the quay phase can significantly reduce the emissions from berthing ships (Kotrikla et al, 2017; Rolan et al, 2019).

Moreover, Spengler and Tovar (2021) suggest that even without integration of renewable energy sources into the grid, onshore electricity provided by oil-fired power plants could significantly reduce external costs associated with in-port emissions (Spengler, 2021). By combining the global and local externalities of ship emissions, Spengler and Tovar (2021) calculate the potential gains of cold ironing in Spanish ports, which means a reduction in annual external costs of up to tens of millions of euros for certain port cities (Spengler, 2021). On the other hand, power supply to ships on land requires a complex electrical interface described in Coppola et al (2016) (Coppola, et al., 2016). Zis (2019) argued that the main obstacle to the rapid increase in CI availability was the lack of sufficient ports with the necessary

technological infrastructure and the rarity of refurbished ships that could be connected to a grid on land (Zis, 2019). The same article discusses that factors such as extensions of the geographic scope of low sulphur regulations may force ship operators to invest in universal solutions such as scrubbers rather than invest in CI improvement. It depends on the energy mix as suggested in Zis et al. (2016), cold ironing also has a disadvantage in terms of transmission and energy conversion losses, which can lead to underestimation if not included in emission calculations (Zis, et al., 2016).

A not-so-sophisticated but effective technology being deployed to cap emissions in port areas is the Automatic Mooring Systems (AMS). AMS do not only promise reduction in emissions but they also promise a productivity increase by decreasing the time spent on mooring/unmooring operations. AMS are machines consisted of vacuum pads placed on remote-controlled robotic arms which can stretch out to a ship's hull and stabilize it for port operations. While mooring a vessel by using traditional rope systems take minutes, it only takes seconds with the AMS. The purpose of this technology is to reduce the time a vessel spends manoeuvring by the quays, thus the amount of fuel burnt by marine engines. This simple principal of the AMS makes it a safer and more feasible investment which can be realised in many commercial ports giving service to various types of vessel. In a case study focusing on a certain Ro-Ro/Pax port, Díaz-Ruiz-Navamuel et al (2018) compared the traditional mooring method and the AMS in terms of emissions by using an estimation model combining the EPA and the ENTEC methods. According to the calculations of Díaz-Ruiz-Navamuel et al (2018), using AMS technology reduce emissions during mooring operations by 96.67% (Díaz-Ruiz-Navamuel, et al., 2018).

3. ANALYSIS

In this study, data on the duration of the ships hotelling at the quay and the amount of ship emissions at the quay were analysed with statistical comparative analysis. It has been assumed that one generator of a ship is running at the maximum continuous rating. Normally fuel consumption for every different brand and type of engines are different but for approximation for consumption of similar kind of high speed diesel engines Turkish Maritime Administration's set value of 134 g/kW-h has been used (IMAMB CoS., 2019). Thus, ships' hotelling time at quays and the total yearly emission amounts of them for the years 2019 and 2020 were estimated and compared with graphs. For this study, bar graphs in SPSS program were used (IBM. In Figure 1, there is comparison of ships' hotelling times for 2019 and 2020 years. According to this, it is seen that, the longer time of hotelling belongs to S11 in 2019 and S04 in 2020.

In Figure 2, there is total emission rates at the quay for 2019 and 2020 years. According to the 2019 version (updated in October 2020) of European Environment Agency's air pollutant emission inventory guidebook, the coefficients of PM, NO_x, and non-methane volatile organic compounds (NMVOC) for auxiliary high speed marine diesel engines are 3.5, 47.6, 1.7 kg/tonnes fuel, respectively (EMEP/EEA., 2019). Therefore, in 2019, the total emission rates of PM, NO_x, and NMVOC at the quay are 17.18, 233.70, and 8.35 metric tonnes respectively. In 2020, the total emission rates of PM, NO_x, and NMVOC at the quay are 19.03, 258.81, and 9.24 metric tonnes respectively. In accordance with the results, the more emissions have occurred at the quay in 2020 than in 2019.

It can be understood from the figures that how many days the ships made a hotelling at the Ro-Ro quays separately in 2019 and 2020. Some ships have never came to the quay for 2019 or 2020. For this reason, the graph information of some ships which belongs to 2019 or 2020 has one column.

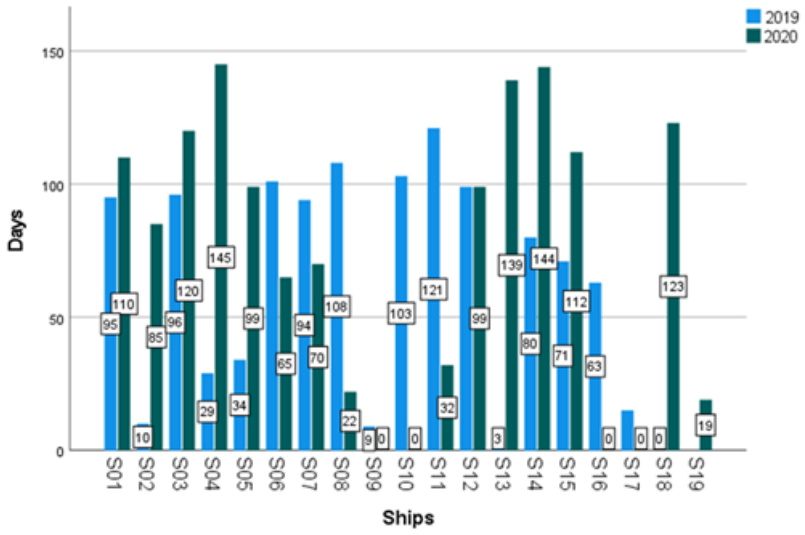

Figure 1. *Hotelling times at port for ships in 2019 and 2020*

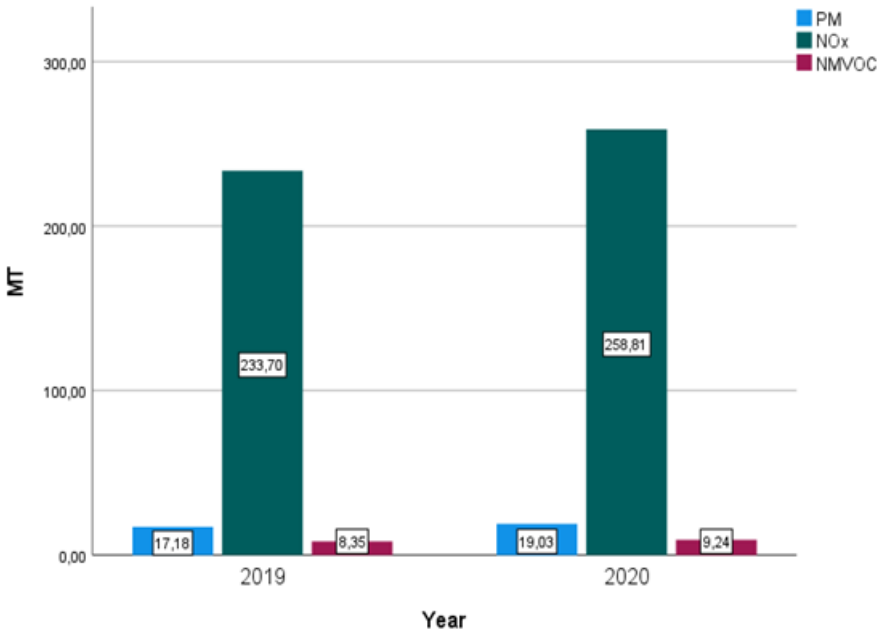

Figure 2. *Total emission rates at the port in 2019 and 2020*

4. CONCLUSION

Reducing greenhouse gas emissions is key to avoiding the most devastating effects of climate change. It is well accepted that ships are responsible for about 1 billion tons of GHG emissions. This fact alone underlines the important role of IMO and local maritime authorities in fighting climate change and pollution.

Due to the lack of a comprehensive historical database on shipping emissions, it is unable to determine which ship types have been accounting for the bigger parts of shipping emissions and thus have more responsibility in air and marine pollution. However, with environmental disasters claiming hundreds of lives, human beings are at point where every effort to fight climate change counts.

In this study, the emission data of ships at the quay of a Ro-Ro port in Tuzla for two consequent years, 2019 and 2020 were compared. Total emission rates by year are shown in Figure 2. In 2019, the total emission rates of PM, NOx, and NMVOC at the quay are 17,18, 233,70, and 8,35 metric tonnes respectively. In 2020, the total emission rates of PM, NOx, and NMVOC at the quay are 19,03, 258,81, and 9,24 metric tonnes respectively. It is seen that the values have increased in general terms. It was observed that the most significant increase was in NOx emissions.

According to calculations made, it can be said that there is no decrease in the emissions caused by the burning of hydrocarbon fuels in the generators of the ships approaching at the Ro-Ro ports in 2020 in Tuzla region, but an increase compared to the previous year, 2019.

In Karl et al. (2019), the Community Multiscale Air Quality Modeling System (CMAQ) model and the System for Integrated Modelling of Atmospheric Composition (SILAM) model were compared and used by comparing to EMEP model. It has been seen that CMAQ and EMEP models give similar results and different results than SILAM model. Additionally, it has been observed that three different models give different results, particularly in PM emissions. (Karl, et al., 2019). Calculations of emissions, particularly PM emission calculations, can also be performed with the CMAQ and SILAM models, in addition to the EMEP model, which is a model that is continually undergoing development.

In conclusion, it is seen that the COVID-19 pandemic did not affect Ro-Ro transportation in Tuzla Port. Therefore, higher quantities of in port emissions occurred at the Tuzla Port from Ro-Ro ships' generators in 2020 than in 2019. Although it is clear that the logistics networks were damaged during the COVID-19 pandemic, the increase in the total need for goods with the increasing population may have caused this situation. The temperature of the planet we live on is increasing day by day. Even the smallest increase in temperature on earth can have a significant impact on the outcome. As more heat is retained in the atmosphere, seawater temperatures will increase along with it (Galashev, 2011). The use of new technologies such as cold ironing to reduce the GHG released into the atmosphere by the ships at the quay may help to reduce the problem to some extent. With more detailed and more precise studies to be carried out in the future, the ecological effects created or to be caused by emissions and the harms to nature they may cause to environment and human health should be revealed more precisely and appropriate environmental policies can be developed.

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