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Environmental cost and eco-efficiency from vessel emissions in Las Palmas Port

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ABSTRACT

This study presents external costs and eco-efficiency parameters associated to exhaust emissions in Las Palmas Port. Emission assessment is based on a vessel emissions inventory obtained from the full bottom-up Ship Traffic Emission Assessment Model and messages transmitted by the Automatic Identification System over 2011. External costs are estimated based on a top-down approach. Results are combined with port operations profiles resulting in eco-efficiency performance towards economic and environmental concerns in Las Palmas Port. Results could also support the valuation of instruments to abate emissions in crowded port-cities that as Las Palmas, host a large population of residents and visitors.

1. Introduction

Exhaust emissions from shipping are a major concern towards environmental and human health protection. Impact of hazardous pollutants released into the air negatively affects communities located near the coastlines and the built environment of port-city areas. Mitigation strategies contribute to the overall picture of the issue. Yet, the contribution and the economic impact of air emissions released by vessels operating in port remains in many cases as unknown or uncertain.

Emissions released at port and by operating vessels in harbour contribute with a small percentage when compared to the total amount released by shipping. Nevertheless, they inevitably constitute a source of pollution concentration in the air. In addition to GHG, the urban character of ports and their populated surroundings are a main focus of the negative effects of exhaust pollutants (NOx, SO_x, VOC, CO and PM) associated to local impacts on human health and built environment.

The need to abate air pollution is widely acknowledged as a policy issue in ports and harbours. Emission control requires the ability to quantify emissions and to develop accurate emission inventories for ports. Indeed, emission information is necessary to properly assess the impacts of port improvement projects or growth in shipping activity, as well as to plan mitigation strategies or voluntary programs and to aid policy makers towards the development of effective regulatory requirements at national and international levels.

In order to be reliable, it is suggested that port emission inventories, should be based on real vessel traffic information, ship engine ratings and operative times corresponding to each vessel tracked. In despite of this, assumptions in port traffic

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are regularly made and bias emission inventories may be produced with the use of a top-down approach; or a bottom-up approach[2] based on port calls (Tzannatos, 2010a). According to recent quality control analysis performed on the Third IMO GHG Study (2014), quality advantages for the bottom-up activity-based inventories relate to the use of calculations for individual vessels, performed either with port calls or vessel tracks. Nevertheless, by maximising vessel-specific activity characterisation using AIS data sources (as it happens with vessel tracks), estimations account the variability among vessels within a type and size category. This eliminates the dominant uncertainties reported by previous vessel emission inventories at port.

The external cost of air emissions released at port, by ships, starts to be addressed in literature (i.e. Miola et al., 2009; Tzannatos, 2010b; Castells et al., 2014; Song, 2014; Maragkogianni and Papaefthimiou, 2015). Yet, scientific evidence on externalities and costs directly related to vessels is still at an initial stage, and improvement requires of sufficient and refined information. Indeed information quality is key and of particular interest to cost-benefit analysis when compared with the economic benefits, the costs estimated attempt to support burden-reduction measures (Tzannatos, 2010a). The analysis of external cost is achieved in two stages that first involve the quantification of air emissions. In this respect, a substantial amount of research investigating ship emissions has been addressed using methodologies that are either based on marine fuel sale statistics (Jiang and Kronbak, 2012) or on vessel traffic information. It should be noted that data input to estimate the activity of vessels entail differences based on its source,[3] type (ports of call or vessel tracks) and the precision level provided by the information. Indeed, while the ports of call indicate the origin and destination of the vessel route excluding operative details; the AIS[4]-transmitted vessel tracks regularly updates the unique identification of the vessel, its position, course and speed with a rate that may go from two seconds to six minutes according to the vessel status and to the communication systeḿs protocol (ITU-R, 2010).

Integrating high-definition traffic information avoids operative assumptions of vessels and estimations are enabled with a greater precision based on the most reliable information presently available. In addition to this, geographical characterisation of pollutants may be accounted due to the speed and route of ships being known. Recent research on ship emissions based on high-definition traffic information (vessel tracks with an update rate of one minute) has been pursued in Las Palmas Port (Tichavska and Tovar, 2015a).

Located in the Atlantic Ocean, Las Palmas Port is the fourth largest port within the Spanish system and a major logistic platform between Europe, Africa and America. Its location between main commercial trade routes makes it a cargo hub[5] with over 19 million tons from loading, unloading and transshipments; and also a leading worldwide bunker trader. Ferry routes are offered in a daily basis with hub operations set in the main Canarian ports.[6] In addition to the regular ferry services, cruise operations in the Canary Islands increase steadily (EDEI, 2011). According to Las Palmas Port Authority, passenger share of Las Palmas Port increased in over 20% with a total of 1,605,531 passengers in 2013. A sustained market growth increases the need to identify and measure environmental impacts generated by shipping traffic. Particularly with the aim of reducing related externalities as generally pursued in many other harbours in Europe.

Las Palmas de Gran Canaria is the most populated municipality and capital of Gran Canaria Island, and the ninth largest city in Spain with a population of 383,343 inhabitants in the period of study (2011). It is divided into five administrative districts and sub-districts (see Fig. 1). The most populated are namely: (D1) Vegueta, Cono Sur y Tafira, (D2) Center, (D3) La Isleta-Puerto-Canteras and (D4) Ciudad Alta; all located near operative quays of Las Palmas Port, the main city beaches, and commercial areas. The great economic engine of the island is tourism. Nevertheless, commercial activity is also noteworthy, particularly in the vicinities of the port area, located in the capital. There is a small industrial sector, primarily focused on food production, light manufacturing and cement. In addition to this, agriculture remains as an economic activity of relevance in rural counties, but this is experienced in a minor extent when compared with past years.

The present study extends the vessel emission research in Tichavska and Tovar (2015a); to the estimation of external costs and the eco-efficiency performance of Las Palmas Port. This has been firstly motivated by the identified contribution of vessel emissions in harbour and, by the need to address its economic impact and derived eco-efficiency performance of vessel emissions. Results attempt to indicate performance of Las Palmas port towards social, economic and environmental concerns. Aim of this approach is to support an environmental operation model, which extends value-based management exploring relations of economic and ecological capital efficiency. Also, eco-efficiency results aim to facilitate future cost-benefit analysis used for evaluating abatement policy instruments in Las Palmas, where a large population of residents and visiting tourists are continuously hosted. Finally this study, also contributes to recent literature of vessel emissions, externality costs and eco-efficiency by describing through the case study, the utility of these measurements as support tools to Port Authorities and local governments. The structure of this document is described below.

[2] A bottom-up approach is referred to calculations based on fleet activity. This can be done by using port calls and estimated vessel operative or, through vessel tracks and real time operative of vessels. On the other hand, a top-down approach is referred to estimations based on fuel sales statistics.

[3] Fleet activity information may be acquired either from public authorities (port call records) or from automatic transmission of data fields from individual. The latter possibility was originated by the vessels mandatory communication protocols regulated by the IMO.

[4] Starting 2002, the protocol transmitted by the AIS includes vessel tracks (Lon, Lat, Status, Speed, Course, heading and Timestamp) and particulars (unique identification number, vessel name, type, dimensions, flag and others) in its messages.

[5] Regarding transhipment, the international hub in the Canary Islands is located in Las Palmas port (Tovar et al., 2015). Driven mainly by container operations, the transshipment traffic in Las Palmas Port has reached a rate close to 69%, whereas Tenerife port focus its container traffic merely on the domestic market.

[6] The seven Canary Islands are situated 115 km from the northwest African coast. The Canary Islands main ports are Las Palmas Port (located in Gran Canaria) and S.C. Tenerife Port (located in Tenerife). They are managed by different Port Authorities. A detailed analysis of the port management model in Spain is beyond the scope of this paper but it can be found in Rodriguez-Álvarez and Tovar (2012) and Tovar and Wall (2014).