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Sustainability of port activities within the framework of the fisheries sector: Port of Vigo (NW Spain)

Carla Lopes[a], Luis T. Antelo[a], Amaya Franco-Uría[a,b,*], Carlos Botana[c], Antonio A. Alonso[a]

[a] Process Engineering Group, Marine Research Institute IIM-CSIC Eduardo Cabello, 6 – 36208 Vigo, Spain
[b] Department of Chemical Engineering, School of Engineering, University of Santiago de Compostela, Campus Vida, 15705 Santiago de Compostela, Spain
[c] Environment Division, Vigo Port Authority, Plaza de La Estrella, 1 – 36201 Vigo, Spain

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ABSTRACT

Sustainability of the fisheries sector is nowadays a key issue due to the significant impact that this activity may have on the environment. Besides fishing activity itself, other indirect impacts, like those originated from related activities and services also need to be addressed. For assessing the environmental burden of this sector, the Ecological Footprint (EF) indicator can be used. The application of EF to the fisheries sector is still uncommon and studies of associated activities (such as ports) even more. In this work, classical EF methodology was applied in order to evaluate the environmental impact of the fisheries sector, taking as a representative sample the global activity (fishing and transportation) of the Port of Vigo (Spain), one of the biggest fishing ports in the world. A high value of total EF for both port and fishing activities was obtained. However, relative EF is much higher in the case of fishing, due to the low natural productivity associated to fish resources. Energy-land and sea area were the most affected land-components within the footprint, while among the different categories, resources consumption was the main contributor to the EF value in all the assessed scenarios.

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1. Introduction

It is well known that marine ecosystems supply an extensive variety of goods, facilities and also food resources for humanity (Worm et al., 2006). For this reason it is essential to protect this ecosystem, considering that the current practices within the fisheries sector are depleting marine resources and endangering biodiversity (Worm et al., 2009). The reduction of fisheries catch can be both related with the exploitation of fishing resources and with chronic pollution (Jackson et al., 2001). An evaluation of fishing sustainability is needed to know which are the main aspects influencing the depletion of marine resources. Therefore, recovery of marine ecosystems is essential to achieve oceans sustainability (Pauly et al., 2002, 2003; Worm et al., 2009; Norse et al., 2012). A study developed by Swartz et al. (2010) showed that the worldwide development of marine fisheries through the past years was conducted by a continuous exploitation of new fishing sites. The fast decreasing of marine fisheries catches indicates a global limit to growth and highlights the crucial need for a change to sustainable fishing. Nowadays, fisheries cover a wide deep-sea area of the world, with sites of low productivity and distant waters, which implies an important consumption of fossil fuel, compromising the sustainability of fishing activity.

On the other hand, associated services necessary to facilitate fisheries trade are also a source of important environmental impacts. Within these services, port infrastructures play a critical role. Furthermore, in the port area, other important environmental impacts resulting from port activities can happen: small oil or fuel spills, gas discharges and even cleaning of storage tanks pose a relevant impact on the port area. Sometimes, small fish, fish guts, shells from shellfish or fish in a bad condition to sell (e.g., smashed or poorly preserved) are inappropriately discarded in the sea or nearby, where they can contribute to port pollution. Although there are entities within the ports that control, prevent and manage this kind of emissions, uncontrolled emissions can happen occasionally, being their quantification very difficult. Hence, all the environmental impacts caused by port activities should be evaluated and, if it is the case, reduced. For that purpose, the first step is to correctly manage environmental issues, which requires environmental monitoring (Darbra et al., 2009). In that context, the Ecological Footprint (EF), introduced by Rees (1992) and further developed by Wackernagel and Rees (1996), is an important tool for quantifying the impacts generated and the sustainability of several activities and/or products. One of the main advantages of EF is its ability to inform general public about the impact that an activity and/or product has on the world's biocapacity, being

* Corresponding author at: Department of Chemical Engineering, School of Engineering, University of Santiago de Compostela, Campus Vida, 15705 Santiago de Compostela, Spain. Tel.: +34 881 811 000.
E-mail address: amaya.franco@usc.es (A. Franco-Uría).

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also scientifically robust. The EF is an indicator that considers the energy and raw materials fluxes to and from any particular system, converting them into spaces of land or water necessary by nature for producing and/or assimilating these fluxes. Although EF was firstly developed to account for the consumption of natural resources depending on the lifestyle of nations and regions (Wackernagel, 1998; Lenzen and Murray, 2001; Wackernagel et al., 2004; Chen and Chen, 2006; Siche et al., 2008, 2010; Scotti et al., 2009; Galli et al., 2012; Niccolucci et al., 2012), improved methodologies allow the application of the EF to a wide variety of sectors and activities (Kautsky et al., 1997; Roth et al., 2000; Gössling et al., 2002; Stöglehner, 2003; Frey et al., 2006; Huijbregts et al., 2008; Liu et al., 2008; Niccolucci et al., 2008; Cerutti et al., 2010, 2011; Gondran, 2012). Pressure of nations on marine ecosystems has also been assessed by modified EF methodologies (Bonfil et al., 1998; Folke et al., 1998; Talberth et al., 2006; Swartz et al., 2010). In fact, there are only a few works related with the application of EF to the fisheries sector, although the concept of marine footprint was previously used (Parker and Tyedmers, 2012), or to port activities, this latter mainly regarding administrative issues (Carrera-Gómez et al., 2006; Doménech Quesada, 2006; Millán et al., 2008).

The fishing sector in Galicia represents an important contribution to the total volume of captures in Spain and is considered as one of the largest in the European Union. In this region, there are many companies related to fishing activities, from small-scale (inshore and coastal) fisheries catches to fish canned-industries, including some of the largest fishing companies in the world (e.g., Jealsa, Calvo, Pescanova). Lately, the Galician fishing sector has suffered a significant reorganization, allowing for less but more competitive companies. The relevance of this sector is however, essentially connected to the size and value of captures (Doldán-García et al., 2011). The Port of Vigo (SW Galicia) is one of the biggest fishing ports of the world. Thus, a representative part of the fishing extractive sector relies on port activities. On the other hand, there are other important activities within the port (such as goods transportation, fish processing, administrative services, etc.) which also require resources consumption and thus, need to be evaluated.

The objective of this work is to quantify the environmental impact of the total activity (fishing, transportation of goods and services) of the Port of Vigo through the application of a classical sustainability indicator, EF (Wackernagel et al., 2005). The results obtained will provide information to the Port Authority (PA) on the principal impact categories, in order to take the necessary measures to improve its environmental management strategy, and specially to optimize the traffic of fishing vessels.

2. Materials and methods

2.1. Port activity

The Port of Vigo is dedicated to two main activities: fishing and transportation of goods. It is considered as one of the biggest ports in the world in fishing for human consumption (unloaded fish in 2010 reached a record value of 788,901 tons), and also one of the biggest in goods transportation (around 3.5 million tons in 2010), which includes ro-ro traffic, containers, liquid and solid bulks, etc. The PA is the leading entity of all port actions, being responsible for management, administration and operation of the port. Part of the port activity is directly managed by the PA, while other sectors are controlled by private organizations which act as licensed enterprises. A flow chart of port operations is shown in Fig. 1. The port covers several activities such as controlling of sea and land traffic, storage, loading and unloading of different products, fishing activity, administrative services, building and repair of vessels, sanitation services, emergency and maintenance operations, dredging, and MARPOL waste treatment, together with other less important activities (Peris-Mora et al., 2005). The PA is responsible of guarantying that the licensed companies, vessels, clients and other suppliers comply with the law. The certified companies (in most cases, small fish processing companies) are obliged to deliver to the PA environmental information in accordance with their activity, as required by the legal regulations (resources consumed and waste produced). However, only part of the activity of the private companies operating within the port limits is incorporated in the current inventory data due to availability problems, although their resources consumption (and the wastes generated) are expected to be low, based on their production. As a rough estimate, the activity of these companies should pose between 1% and 5% of total port activity. In this case study, therefore, only operations directly managed by the PA were assessed. The inventory data for performing EF analysis was provided by PA, which includes the main activities of the Port of Vigo, fishing activity, the transportation of goods, PA services and the main part of the fish processing companies' activities.

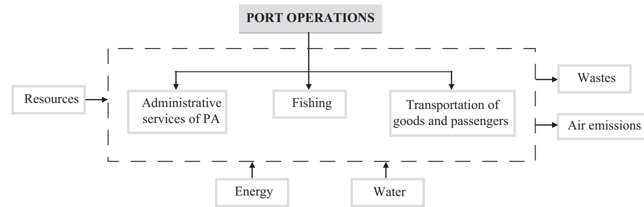

Fig. 1. Flow chart of port operations in the Port of Vigo.

2.2. Data collection and methodology

The different flows of materials and energy were compiled for the year 2010, and can be seen in Table 1, grouped according to the different categories (energy consumption, resources consumption, and waste generation). The fishing activity causes different impacts on the environment, as the space used for fishing activities, the consumption of fuel by vessels, the consumption of different materials (nets, boxes, hooks, etc.) and other resources (paper, water, etc.), and by producing emissions, discharges and wastes (Doménech Quesada, 2006). Although in the current study the space used both for fishing and port infrastructure represents an extensive area, this was not considered in the analysis, since the aim of the present work was only focused on the activity itself. Besides, the ports have the particularity that much of their land is built on water (as in the case under study), including fishing activity, which is much less productive than terrestrial soil. For this reason, the "equivalents hectares" (real hectares by the equivalence factor) are, in fact, much lower than the real available land. This criterion underestimates the structure constructed at sea neglecting other impacts directly affecting coastal degradation (Doménech Quesada, 2006). The Port of Vigo is partially constructed on a Galician Ría. The Rías are known worldwide to have a unique ecosystem, very rich in nutrients and thus, highly productive (Nogueira et al., 1997; Ríos et al., 1998; Alonso-Gutiérrez et al., 2009). Therefore, productivity in this case could be comparable to terrestrial soil, and the impact of building on sea area would be much less efficient than thought at first glance. Nonetheless, only the consumption of resources and the waste generation were considered for evaluating the sustainability of the activity (fishing, transportation of goods, fish processing companies and PA services). Consequently, it has to be taken into account that the calculated value of the EF will be slightly underestimated.

Flows were converted into bioproductive area by specific equivalence factors for the land use types available from the National Footprint Account (GFN, 2010). The different types of area

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