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USE AND SUSTAINABILITY OF THE SHIPS' WASTE RECEPTION FACILITIES: EVIDENCE FROM THE PORT OF CORINTH, GREECE

USO E SUSTENTABILIDADE DAS INSTALAÇÕES DE RECEPÇÃO DE RESÍDUOS DOS NAVIOS: EVIDÊNCIAS DO PORTO DE CORINTO, GRÉCIA

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Abstract

Nowadays, merchant ships are carrying all kinds of modern world commodities, but during their operation produce waste. Therefore, sustainable management is necessary. Currently, a set of measures have been activated in order to address this potential threat based on strict legislative framework. This study will attempt an approach, in order to clarify the current and future adequacy of the ships' waste reception facilities at the port of Corinth in Greece within the limits of the existing and forthcoming management regulations. The current research followed an extensive quantitative and qualitative methodological approach. Results evince that the port of Corinth is not currently considered at risk from irregular ships' waste discharges into the marine environment. However, considering the latest adopted expansion master plan, port facilities appear partially adequate to manage the additional burden. Therefore the establishment of permanent reception facilities is suggested.

Keywords: merchant shipping, ships' waste management, waste reception facilities, sustainable management

Resumo

Hoje em dia, os navios mercantes estão transportando todos os tipos de mercadorias do mundo moderno, mas durante sua operação os navios produzem resíduos. Portanto, o gerenciamento sustentável é necessário. Atualmente, um conjunto de medidas foi ativado para abordar essa ameaça potencial com base num quadro legislativo rigoroso. Este estudo tentará uma abordagem, a fim de esclarecer a adequação atual e futura das instalações de recepção de resíduos dos navios no porto de Corinto, na Grécia, dentro dos limites dos regulamentos de gestão existentes e futuros. A pesquisa atual seguiu uma extensa abordagem metodológica quantitativa e qualitativa. Os resultados evidenciam que o porto de Corinto não é atualmente considerado em risco pelas descargas de resíduos que produzem os navios irregulares no ambiente marinho.

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No entanto, considerando o mais recente plano mestre de expansão adotado, as instalações portuárias parecem parcialmente adequadas para administrar o ônus adicional. Portanto, é sugerido o estabelecimento de instalações permanentes de recepção.

Palavras-chave: transporte mercante, gestão de resíduos dos navios, instalações de recepção de resíduos, gestão sustentável.

Introduction

For modern societies, the sea is a source of wealth (Zervas, 2014). International trade, transportation, energy supply, fisheries, tourism, planet climate, human health, sustainability etc are sea-based activities crucial for the economic development of modern societies (García Negro, Villasante, & Carballo Penela, 2007; Katsanevakis, 2008; Vinogradov, 2013). However, these activities are putting severe and continuous environmental pressures, which pose a threat to environmental and human health (Psaraftis, 2002). Firstly this issue was not dealt properly due to the high resilience of the marine environment. After the second world war, ships' waste marine pollution began to become perceptible due to the shipbuilding technology development which led to the first huge oil spill and triggered global interest (Aristotelis Alexopoulos & Konstantopoulos, 2009; Stalcup, Yoshioka, Kaiman, Siegmann, & Masters, 1995). Although marine pollution from ships was already well recognized almost a hundred years ago (Camphuysen & Heubeck, 2016), marine pollution term was first used in 1972 in the Stockholm Declaration on the environment (UN, 1972).

According to the existing literature and data, ships are a major source of marine pollution (Nievas, Commendatore, Olivera, Esteves, & Bucalá, 2006; Tselentis, 2008). Ships' waste management, both cargo waste and ship-generated waste, is a subject of great interest as part of the broader issue of marine pollution (Olson, 1994; Ünlü, 2016). Thus, a set of measures has been adopted in order to address this potential threat. Currently, those measures are based on a strict legislative framework and international conventions aimed at preventing marine pollution (Carpenter & Macgill, 2003, 2005). Nowadays, merchant shipping is the main mean of goods transportation around the globe, thus being an activity producing significant amount of waste (Horsman, 1982; Zuin, Belac, & Marzi, 2009). Therefore, and since ships' waste constitute a threat to the environment (Butt, 2007), sustainable management is necessary. The basic legislative framework regarding the ships' waste is summed up by the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78) (Kasoulides, 1989) and the 2000/59/EC Directive, as amended and in force, which both lay down specific restrictions and procedures for the safe ships' waste discharge to ports (Vlachos, 2007).

Greece is considered as one of the world's largest maritime powers. The policy controlling port operation includes a variety of necessary measures to prevent marine pollution. However, difficulties occur in the implementation of the legislation, due to the country's particular geography, with a long coastline (approximately 16.500m), a vast number of islands, as well as more than 100 of commercial and tourist ports, marinas, fishing shelters, etc (Chlomoudis, 2006; Alexopoulos and Fournarakis, 2015), a phenomenon expected to become worse, should the marine traffic increases as expected..

The Aegean Sea, although a vulnerable sea zone is also a heavy-duty transport hub (Katsanevakis & Katsarou, 2004). There are about 60.000 merchant ships navigating in the Aegean Sea annually (www.yen.g). Many actions, legislations, programs and initiatives have been made over time on behalf of the Greek Ministry of Maritime, body responsible for protecting the marine environment in Greece (Ventikos & Giannopoulos, 2013).

The port of Corinth is located southeast of the Corinthian Bay, just 2 km from the northern end of the Corinthian Canal and 140 km from the Charilaos Trikoupis Bridge. Corinth City is the capital of the Corinthian Prefecture, hosts 36.555 residents (www.statistics.gr) and historically the port is considered an integral part of urban life. As provided by the Greek Common Ministerial Decision No 3515.96 of February 1992 the port of Corinth, serving local needs but mainly as a cargo exporting facility, is classified as a port of national importance, as it is a crucial link of the national transportation network, holding a strategically important position and having development prospects, which may influence the local socio-economic conditions. Furthermore, according to the

aforementioned classification, the port authority is obliged to implement all the relevant waste management provisions. The port is an artificial harbor protected by a concrete mole with depth of approximately 9 m, length 930 m, width 100 m and a mole surface of about 93.000 m². The port operates as a facility for general cargo ships, bulk carriers, ROROs, ferries and tourist ships of 80 m maximum length. The fishery shelter, located at the southeast part of the port, can accommodate up to 140 fishing vessels. There are two main size restrictions of the ships willing to call at the port of Corinth; a. the Charilaos Trikoupis Bridge which allows ships of 50 m maximum height to pass under and b. the 8 m depth Corinth Canal which can only handle ships of 24.6 m maximum width to cross. Under these restrictions, currently the port is without significant tourist flows (Table 1), thus there are no indications of volatility in the number of incoming ships per year.

The port of Corinth was chosen for case study, not only because it is of national importance, not only because current data reveal that currently is a port without significant tourist flows, however fact as Hall (2001) and Diakomihalis (2007) state is set to change, but also because it is a characteristic waterfront with sufficient prospects of redevelopment, and shares common characteristics and combines certain criteria to a number of ports in Greece and Europe (Gospodini, 2001). Furthermore, given the importance of the port (Zazzara, D'Amico, & Vrotsou, 2012), a master plan³ has been developed and approved aiming at the expansion of the port (Kyramarigiou & Vardopoulos, 2017), which will allow a comparative assessment of the current and the expected state. The expansion includes among others, dredging of the harbor approaches and widening of the pier, construction of a 800 m² building along with a passenger bridge to serve -cruise- passengers, marina development to serve 300 vessels of maximum 20 m length, vessel refloating zones, parking, green areas, office premises. The long-term master plan's objective is to enhance the tourist perspectives of the Corinthian gulf which translates into increase of the number of cruise ships, of passengers and of the in-port stay time of both passengers and ships. Thus the port waste reception facilities will be called to handle greater waste quantities.

Approximately thirty years ago modern societies came to realize and gradually review their perspective regarding resource exploitation, pollution, and waste produced along with their non-discrete correlation with the environment and the economy. This awakening has helped charting a new world order concerning development and the environment, which prospects for reconciliation between human economic activities and its environmental impacts; namely sustainable development. Hence, in order to obtain equilibrium and therefore to protect future for the next generations to come, sustainable waste management should be ensured, as a collateral guarantee for sustainable development (Poulos, Stamopoulos, Vardopoulos, & Theodoropoulou, 2018), namely economic growth, environmental stewardship, and social inclusion (Rocha, Ávila, & Souza, 2004).

This study will approach the current and forthcoming port waste reception facilities issue for the port of Corinth, in order to clarify the risk in terms of causing marine pollution within the limits of the existing and forthcoming ships' waste management.

Methodology

The current research was based on the following methodological approach:

- i) Analysis of the port's operation data, in order to determine the amount of ships' waste per waste type per year, for five years.
- ii) Estimation, using relevant models⁴, of the amount of expected ships' waste for the same time period.
- iii) Using the same models, estimation of the amount of ships' waste as expected due to the expansion of the port.
- iv) Analysis and comparison of the results of the aforementioned actions.

³ Greek Government Gazette No 194 of 18 June 2014, Corinth's Port Development General Master Plan.

⁴ The estimation models are reference from the European Maritime Safety Agency - EMSA, the European Sea Ports Organisation - ESPO, the IMO | Global Integrated Shipping Information System - GISIS, the Global Maritime Distress and Safety System - GMDSS, the Global Monitoring for Environment and Security - GMES, the Group of Experts on the Scientific Aspects of Marine Environment Protection - GESAMP, the International Maritime Organization - IMO, and the International Convention for the Prevention of Pollution from Ships. Those models beyond the scientific literature are widely used in waste management plan designs.

The comparison revealed a highly significant difference between the current, the estimated and the expected amount of discharged ships' waste. Therefore, further research regarding the causes was necessary. Thus:

v) A qualitative research was conducted, using semi-structured interviews from people ($N=7$) which are directly involved in the current ships' waste management process at the port of Corinth.

Lastly, following the respondents view regarding the master plan's ships' waste reception facilities design,

vi) A study was conducted regarding the potential establishment of permanent ships' waste reception facilities -temporary storage-, using the already approved master plan, in line with the commonly used practices (indicatively: Ball, 1999; Olson, 1994; Palabıyık, 2003; Wilewska-Bien & Anderberg, 2018), in compliance with all necessary international standards and in accordance with the findings of the current research, following a field investigation in order to identify certain port locations that would not interfere with the port operations, are easily accessible, controlled and protected.

Although few have previously conducted research regarding ship's waste port reception facilities, to our knowledge, none has ever proceed using the combination of the above mentioned methodology.

Data were mainly extracted from the relative port archives and the contractor's database, including in detail quantities delivered by each vessel, delivery date and time, type of vessel, port receiving means, etc. More specifically, pollution statistics for Greece were collected from the General Secretariat for the Aegean and Island Policy of the Greek Ministry of Maritime - Directorate of Marine Environment Protection, ships technical characteristics were obtained from the Inspectorate Directorate of Merchant Ships, the General Secretariat of Ports, Port Policy and Maritime Investment of the Greek Ministry of Maritime - Directorate of Port and Building Infrastructure handed over specifications and information regarding the port expansion, data about port traffic were collected from the Port of Corinth Authority and the Corinth Municipal Port Fund, the CNWAY Consulting Engineers MGA company delivered statistics and data resulting from the Corinth's port expansion study, ships' liquid waste management statistical reports were obtained from the HEC S.A. company, while ships' solid waste management data reports were collected from the ANTIPOLLUTION company.

Given the fact that ships' waste management involves many different actors, inevitably temporal limitations are engendered, evidence of the difficulty of collecting data. Thus, from the time required to make the necessary communications and agreements on access to data, from the content of these agreements, and from the range of available data, with each and every different actor, a period between 2008 and 2015 was set, which serves the scope of the current as practically of zero influence on the results obtained. Also in parallel with the scope of the current research, where data were not sufficient, additional data we obtained by field work for the calculations completion.

The data were analyzed and processed in order a) to evaluate the port ships' waste reception facilities from the administrative point of view, b) to assess the risk of irregular ships' waste discharges, c) to examine the current suitability of the port reception facilities with respect to receiving ships' waste and d) to estimate the ships' waste reception facilities adequacy considering the forthcoming expansion.

As estimation models, an approximation calculating method of estimating ship's waste was used, different for each type of waste. These are considered empirical equation models, micro models trying to calculate the total amount of waste bottom-up, from each ship and from person on board, and are broadly used for such estimations (indicatively: Abo Zied, 2017, Palabıyık, 2003). The ships' waste quantities were also estimated provided that all ship-generated waste of the ships visiting the port of Corinth is received by the port's reception facilities. For estimating oily bilge waters, oil residues and the volumes of domestic and maintenance associated waste, two formulas of the model developed for Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea were used. Hence, for the oily bilge water and oil residues (Annex I, MARPOL 73/78), the following formula was considered:

(1)

$$Q_t = \frac{(N_1 \times P_{si} \times T) + (N_2 \times P_m \times T)}{365}$$

In which Q_t represents the volume of oily wastes in m^3 as generated daily by the ship machinery, N_1 is the number of ships calling at the port annually, P_{si} represents the oil residues production in m^3 per day, N_2 stands for the number of the ships calling at the port per year who lack of onboard oily bilge water separator, P_m stands for the oily bilge water production from N_2 number of ships per sailing day, and T is the number of cruising days along with the number of the ships' stay days (call reference). More specifically, for ships calling at the port of Corinth, ie ships of more than 400 registered tonnes (IMO, 2016) and ships with the necessary equipment for segregation and sea discharge, the amount of oil residue is 1% of the daily fuel consumption for petrol engines and 0.5% for diesel engines (Gkarliaridis, 2010). In order to calculate the amount of oily tank washings, the approximation of 6% of the deadweight tonnage was used. (Sotiropoulos, 2013).

Furthermore, for the domestic and maintenance associated waste (Annex V, MARPOL 73/78), we considered the following formula:

(2)

$$A = (N_B \times T_B \times P_B \times 2) + (N_P \times T_P \times P_P \times 3) + (N_H \times T_H \times P_H) + (N \times T \times 11) + \left(W_B \times \frac{1}{123} \right) + \left(W_D \times \frac{1}{10,000} \right) + \left(W_C \times \frac{1}{25,000} \right)$$

In which A stands for the quantity in kg of garbage produced in peak per week, N_B , N_P , N_H is the number of cargo ships, passenger ships and ships engaged in the operation of the port respectively, calling at the port at T_B , T_P , T_H respectively time of period. T_B , T_P , T_H stands for number of cruising days towards calling at the port and port stay of cargo ships, passenger ships and ships engaged in the operation of the port respectively and P_B , P_P , P_H is the average number of onboard people on a traveling typical cargo ship, passenger ship and ship engaged in the operation of the port respectively. 2 (kg/person & day) is the average domestic garbage production rate from traveling cargo ships, 3 (kg/person & day) is the average domestic garbage production rate from traveling passenger ships, and 1 (kg/person & day) is the average domestic garbage production rate from ships engaged in the operation of the port (Beza, Kitsantas and Mitselos, 2014). N represents the number of the in-port ships per week, T is the number of the of ships travelling and staying at the port days, 11 (kg/vessel & day) is the average quantity of maintenance solid wastes generated from a typical ship (EMSA, 2017), and W_B , W_D , W_C is the quantity in kg of break bulk, dry bulk and container cargo respectively, received in peak per week (1/123 is the break bulk cargo waste generation factor, 1/10,000 is the dry bulk cargo waste generation factor and 1/25,000 is the container cargo waste generation factor).

The Greek Presidential Decree No 400/1996 sets the regulations for the prevention of marine pollution from ships' wastewater and the provisions concerning the wastewater collection tanks and the wastewater processing, composting and disinfection systems. The latter, was considered for the estimation of the sewage wastewater (Annex IV MARPOL 73/78) quantities, using following formula:

(3)

$$A = N_E \times T \times Q_E \times P_E$$

In which A represents the volume in m^3 of wastewater expected to be received in peak per week, N_E is the average number of ships without wastewater treatment system calling at the port per week, T stands for the average number of days before arriving and staying in port and concerns a distance of up to twelve nautical miles from the nearest coast, Q_E represents the average daily wastewater production rate and is estimated at about 140lt/day & person (Gkarliaridis, 2010) and P_E stands for the average number of people onboard during ship's voyage. For our calculations, we have taken into account the worst case scenario, namely that the treatment systems are for technical reasons not operational and that the storage tanks are already filled up.

However, despite the fact that the above mentioned calculation formulas are considered to be extremely valuable, in some respects data extracted and used were inadequate to properly feed these models. Thereafter, the acceptance of certain critical estimations and conservative assumptions under which it became possible to have a definite and realistic calculation of the ships' waste discharged at the port of Corinth, was crucial.

For the under study multidimensional issue, the qualitative research of semi-structured interviews was considered the most suitable approach. There are no indications of ever having conducted a qualitative research entailing evidence of the competent bodies both state

administration and private undertakings. Reason to that, to our understanding, partly lies to the fact that the representatives of the competent bodies, which can be regarded as experts by experience and expertise, are hardly willing to reflect personal experiences and beliefs (probably bound by private work agreement). The sampling did not aim to carry out a representative sample, but was used as a strategic research tool, to provide an authentic outcome. This became possible by selecting individuals playing an active role in the waste management mechanism and are thus anticipated to obtain valuable information. The interviewees⁵ were recruited via contacting the competent bodies, namely the port of Corinth Authority, which is responsible for checking compliance with statutory procedures, Corinth's Municipal Harbor Fund, which is responsible for organizing the entire process, the two private undertakings⁶ which collect ships' waste from the port of Corinth and the Greek Ministry of Maritime which is responsible for the port facilities and the overall supervision of the procedures followed. The interviews were drawn with careful and consistent phrasing of unambiguous and easily understood questions, related to the expertise of the interviewees, in order to ensure that they assist, rather than impede the flow of information. Data processing and analyses followed, including coding words and sections from the discussions, allowing us to analyze the frequency and relationships across thematic topics. None software was used for the above mentioned process and none quantitative data were collected and used in this case.

Results

In Table 1 we present the ships arrival at Corinth's port per ship type as recorded for the time period from 2008 to 2015.

Table 1: Number and type of ships calling at Corinth's port (2008-2015)

| | Cargo | Tow ship | Cargo /car ferry | Fishing ship | Crude oil carrier | Passenger /car ferry | Passenger /tourist | Cruise | Total |
|-------------------|-------|----------|------------------|--------------|-------------------|----------------------|--------------------|--------|----------------|
| 2008 | 77 | 98 | 297 | 5 | 17 | 12 | 11 | 7 | 524 |
| 2009 | 69 | 93 | 230 | 11 | 43 | 23 | 59 | 5 | 533 |
| 2010 | 79 | 81 | 181 | 2 | 19 | 80 | 135 | 15 | 592 |
| 2011 | 58 | 84 | 132 | 0 | 3 | 81 | 132 | 14 | 504 |
| 2012 | 53 | 80 | 147 | 0 | 0 | 2 | 103 | 0 | 385 |
| 2013 | 29 | 50 | 74 | 0 | 0 | 15 | 108 | 2 | 294 |
| 2014 | 50 | 45 | 2 | 0 | 0 | 47 | 25 | 3 | 172 |
| 2015 | 42 | 67 | 0 | 0 | 0 | 19 | 37 | 9 | 174 |
| Total | 473 | 598 | 1063 | 18 | 82 | 279 | 610 | 55 | 3178 |
| Average per year | | | | | | | | | 397.25 |
| Average per month | | | | | | | | | 33 ships/month |

Sources: Port of Corinth Authority, Corinth Municipal Port Fund

The amount of waste water that was found to be delivered to the existing port ships' waste reception facilities for the period from 2008 to 2015, using the aforementioned data are presented concisely in Table 2. Respectively, the solid waste amounts are presented in Table 3.

Table 2: Ships' liquid waste quantities received by the port of Corinth

⁵ While interviewees provided invaluable perspective and advice to the authors regarding the under study issue, individual members may have different views on one or more matters addressed in the report. They were not asked to individually or collectively endorse this research's findings and recommendations.

⁶ Hellenic Environmental Center S.A. Antipollution A.N.E.

| Waste Type | | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 (May) |
|----------------------------------|----------------------|------------------|--------|--------|--------|--------|------|--------|---------------|
| | | quantities in m3 | | | | | | | |
| Annex I Oil & Oily water | i.Oil Residues | 739.83 | 576.67 | 491.62 | 197.34 | 214.04 | 0.07 | 171.49 | 79.99 |
| | ii.Bilge | 427.56 | 342.77 | 304.04 | 302.27 | 185.27 | 0.29 | 10.50 | 12.40 |
| | iii.Lubricating | 12.22 | 0 | 3.69 | 0 | 0 | 0 | 0 | 0 |
| | Total | 1257.61 | 922.44 | 863.36 | 499.61 | 399.31 | 0.36 | 181.99 | 92.40 |
| Annex IV sewage wastewater | Wastewaters | 78.00 | 3.00 | 64.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | Number of Deliveries | 85 | 66 | 69 | 37 | 35 | 26 | 17 | 11 |

Source: HEC S.A. Company

Table 3: Ships' solid waste quantities received by the port of Corinth

| | | 2012 | | 2013 | | 2014 | | 2015 | |
|---------|------------------------------|------|-------|------|-------|------|-------|------|-------|
| | | kg | m3 | kg | m3 | kg | m3 | kg | m3 |
| Annex V | Maintenance associated waste | 600 | 1.2 | 4300 | 0 | 2420 | 0 | 1300 | 0 |
| | Number of Deliveries | 8 | | 19 | | 10 | | 5 | |
| | Domestic associated waste | 0 | 118.7 | 0 | 442.9 | 0 | 339.9 | 10 | 283.8 |
| | Number of Deliveries | 71 | | 155 | | 106 | | 87 | |
| | Total quantities | 600 | 119.9 | 4300 | 442.9 | 2420 | 339.9 | 1310 | 283.8 |
| | Total numbers of quantities | 79 | | 174 | | 116 | | 92 | |

Source: ANTIPOLLUTION Company

Based i) on port traffic as recorded the last five years, ii) on the reports of the ships arriving in and/or departing from the port of Corinth and iii) on the above mentioned estimation models in Table 3 we present our initial estimations of the waste quantities that the port of Corinth is called upon to manage.

Table 4: Waste quantities projections that the port of Corinth is called upon to manage

| Waste Type | Quantities |
|--|--|
| Oil Residues and Bilge Wastewaters ^a | 20 - 25 m3 per day |
| Lubricating Wastewaters ^a | 0,40 m3 per day or 10 m3 per month |
| Sewage Wastewaters ^b | Up to 17 m3 per delivery or 54 m3 per day with three ships simultaneous waste delivery |
| Domestic associated solid wastesc | 6 up to 10 m3 per day |
| Maintenance associated solid wastesc | Up to 12 kg or 0.082 m3 per day |
| Formula 1 was used to calculate the values Formula 3 was used to calculate the values Formula 2 was used to calculate the values | |

Furthermore, based on master's plan estimations regarding port's traffic increase, we present in Table 4 our calculations of the amount of waste expected to be delivered in Corinth's Port.

Table 5: Calculated estimations of the waste quantities expected to be received in Corinth's port after the implementation of the master plan

| Waste Type | Port vessels | Marina vessels |
|--|---|-------------------------------------|
| | Quantities | |
| Oil Residues and Bilge Wastewaters ^a | 25-35 m ³ per day | 17 m ³ per month |
| Lubricating Wastewaters ^a | 0.80 m ³ per day or 12 m ³ per month | 5.0 m ³ per month |
| Sewage Wastewaters ^b | Up to 17 m ³ per delivery or 80 m ³ per day with five ships simultaneous waste delivery | 1.0 up to 1.5 per week |
| Domestic associated solid wastesc | 15-25 m ³ per day | 4.0 m ³ per day |
| Maintenance associated solid wastesc | Up to 20 kg or 0.14 m ³ per day | 3 kg or 0.14 m ³ per day |
| Formula 1 was used to calculate the values Formula 3 was used to calculate the values Formula 2 was used to calculate the values | | |

The general outcome of the qualitative research is that the port of Corinth is not considered unsound regarding ships' waste management. The quantities that are received due to the low traffic of the port are manageable and the port reception facilities along with the in charge personnel are adequate. Additionally, all the proper and approved procedures regarding ships' waste are in compliance with the relative regulations set. Cooperation and communication are good among the competent bodies. Ships requests for waste delivery are reported in a timely manner while already informed of the reception facilities and capabilities of the port. As far as we are aware, no complaints or statements have been submitted in this respect. Serious accidents, incidents, infringements or illegal dumping have not been recorded except one, as Interviewee A⁷ stated, in which situation the case had been addressed directly and properly. Also, all interviewees stated that there are sufficient ways and methods of dealing with minor mishaps. Ships' waste reception facilities and quantities, before the adoption of the relative regulations, are in general not known to the interviewees. Interviewee A states that were received at other ports but interviewees B⁸ and C⁹ state that were dumped in the sea. However, all agree that the implementation of strict regulations altered the attitudes and perceptions regarding the environmental protection while now it is also very difficult to out pass the control mechanisms. We consider quite interesting the view of Interviewee B, who based on his experience, believes that the onboard ships' waste management equipment is not always properly operating, an issue that is quite difficult to check; hence the sea waste dumping exceeds the authorized levels. All interviewees knew that the port has no permanent storage reception facilities, but no-one except Interviewees B and C had a clear picture about the temporary storage facilities. All interviewees made the following note during our discussion; the control procedures which ensure waste deliveries at the port, are under supervision and care by non-specialized personnel (staff without scientific expertise). This precludes the possibility of ship tank inspections, a fact that gives rise to serious risks as the interviewee D¹⁰ stated. After waste quantities are received from the undertakings the state authorities do not keep track of those wastes nor keep any kind of related data according to the interviewees. Data are only kept from the undertakings, regarding time, waste type, receiving location, delivery information in compliance with the relative regulations. However, according to this research, no data is kept regarding quantities, neither recycled and/or recovered and/or re-used waste quantities. At the port of Corinth all liquid ships' waste is received after on board separation procedures as Interviewee C states, in conjunction with the solid ships' waste which according to Interviewee B have never been received separated. Since the port

⁷ Interviewee A - Commander of the Hellenic Coast Guard, Corinth's Port Maritime Prefect, Graduate of the Greek National Merchant Marine Academy - Identification data are available only upon request

⁸ Interviewee B - Manager at Antipollution A.N.E., In charge for monitoring and coordinating ships' waste management on regional ports, Environmental Engineer with master studies in renewable energy and environmental protection - Identification data are available only upon request

⁹ Interviewee C - Manager at HEC S.A., Vice-President of the European union undertakings engaged with ships' waste management, author of the ships' waste management plan for the port of Corinth, Chemical Engineer with master studies in petrochemicals - Identification data are available only upon request

¹⁰ Interviewee D - Warrant Officer of the Hellenic Coast Guard, In charge for the protection of marine environment at the port of Corinth - Identification data are available only upon request

reception facilities are inadequate to fulfil such a separation, all (type of) wastes end up on the sanitary landfill site. Noticeable is also the fact that all interviewees knew the procedures followed in other large European ports and stated that are the same with those followed by the port at Corinth. All interviewees agreed that if the port was equipped with permanent storage facilities for all types of ships' waste, would mean a significant amount of financial savings for the port and state, but again, by interviewee E¹¹ this time, attention was drawn to the necessity for qualified personnel for such a proposal to properly operate. On the other hand, interviewees B and C claimed that since the undertakings possess the know-how, the experience and the qualified personnel, in the interests of all concerned, the latter should keep taking over the task. With regard to the master plan port expansion, all emphasized that it is of great social and financial importance of the surrounding areas, but also important since the port of Corinth with the planned expansion will take a piece of the pressure from the main Greek port, the port at Piraeus. However, the expansion will increase the passenger traffic, which will increase the volume of wastes the port will have to handle. However, Interviewee F¹² noted that no different planning for the in port reception facilities will be drawn, since the most common practice (policy) remains the no permanent storage facilities. Although slight differences in the opinions expressed by the interviewees regarding the fishery ship shelter and the marina, they all agree, given the scale and number of the ships served, that certain areas of permanent storage facilities with the proper staff would be beneficiary to all involved parties, and as specifically Interviewees B and C stated would be financially beneficiary to all parties involved reducing the transportation costs. Finally, all interviewees conclude in that the key for a flawless in port ships' waste management system is coordination and communication among the competent bodies, i.e. between state authorities and undertakings. Inspections carried out by the port authority concern mainly the ships relevant documentation as stated by the interviewees D and E. Onboard sample checks concerning the tank capacity and the operation of the necessary systems is not undertaken as interviewees A and G¹³ mentioned.

The study conducted regarding the potential establishment of permanent ships' waste reception facilities, is presented below. The proposal is presented in furtherance of the uses of the port areas. Hence, with regard to the forthcoming expansion of the commercial port area, the development of permanent oily storage facilities with 20 m³ capacity, which will also serve as temporary storage tanks in each ship berth position, are proposed as indicated in Figure 1. The black pointy symbols indicate the location of the permanent storage facilities while the yellow indicate a roofed area of special temporary storage facilities of 20 m³ which will be able to receive onboard separated ships' waste. Regarding the fishery shelter area it is as indicated in Figure 2 proposed, the establishment of two special tanks of 1 m³ for oily waste and one more of 1 m³ for solid ships' waste. Moreover the establishment of a tank for recyclable waste is suggested. Regarding the marina port area, collection, transportation and temporary storage procedures must follow specific safety principles in order to lessen the impact on the environment. In addition, tanker vehicles are not easy to handle waste discharges at request. Thus, the establishment of two covered areas is proposed as indicated with red pointy symbols in Figure 3, including an oily temporary storage tank of 6 m³ capacity and a temporary storage tank of 1 m³ for hazardous materials deriving from vessels maintenance. For the solid waste, tanks of 1100 liters capacity as indicated with the green cycles in the latter figure are suggested. At the vessel refloating zone, indicated with the purple pointy symbol in Figure 3, the establishment of a 10 m³ capacity container to be used for maintenance and cleaning of vessels large volume non-hazardous solid waste is proposed. Lastly, regarding the port waste waters, the implementation of all modern environmental techniques is suggested, such as permanent sewage collection network with constant monitoring of the marine environmental quality.

All the above mentioned proposals should be roofed were possible in order to protect the facilities from weather conditions, must be securely fenced and protected against overturning, must be hermetically sealed to prevent odor leakage and must be regularly disinfected, should be specially marked to avoid confusion and possible dangerous waste mixture, access for the users must be easy

¹¹ Interviewee E - Petty Officer, first class of the Hellenic Coast Guard, Head of the Port of Corinth Authority Policy Department, Civil Engineer with master studies in the environment - Identification data are available only upon request

¹² Interviewee F - Head of port infrastructure creation and development department of the Greek Ministry of Maritime, Civil Engineer with master studies in in-port infrastructure projects - Identification data are available only upon request

¹³ Interviewee F - In charge for supervising ship's waste management for the Corinth's Municipal Port Fund - Identification data are available only upon request



Figure 3

Conclusion

Results indicated that ships' waste amounts discharged in the port of Corinth are constantly decreasing over the past five years, while ships' waste amounts discharged are significantly less than the amounts resulting using estimation models. The estimated expected amount of ships' waste resulting from the forthcoming master plan implementation is far greater compared both with the current state and the estimated situation. The ships' waste discharged quantities are considered an assessment measure for many factors; evaluation of the performance of the ships' waste management plan, the port's credibility, the financial incentives, etc. Results from the interview process, evince the port of Corinth is not considered risky for irregular ships' waste discharges into the marine environment, with regard to its current operation. The low traffic makes ships' waste management controllable and the port facilities deemed adequate. Despite the fact that the port infrastructure is quite limited, ships' waste received is carried out by heavy goods vehicles specially designed for the purpose. On the other hand, port facilities deriving from master plan, deemed partially adequate. Some of the respondents suggest for the expected amount of ships' waste, a totally different management system, compared with the proposed in the master plan, as more suitable. Namely they suggest the establishment of permanent ships' waste reception facilities with the obligation and commitment to be effectively managed by the port authorities, rather than exclusively be handled -on request basis- by cooperating private undertakings. Hence a conflict of interest between the interviewees coming from state authorities and those coming from private undertakings is witnessed.

The ports authorities do not work together towards informing the ships' waste bulletin for every ship and do not maintain a computerized database on ships' waste. The substantial reduction of scheduled marine routes, caused by the financial difficulties in Greece, has as a result the reduction of the total ships' waste amount. Also, the ships' waste discharge amount per ship is evidently decreasing also because of the financial difficulties, with respect to the reduced commodities delivered, resulting in reduced time ships spent off at the port, driving them to discharge their ships' waste at the next port. Also, the authors strongly believe that economic incentives (Carpenter & Macgill, 2001; Georgakellos, 2007) are not strong enough in order for ships to ultimately discharge their waste at the port of Corinth, while noticeable is that none of the interviewees shared a similar thought.

Although the Municipal Harbor Fund of Corinth is the competent body for organizing and supervising the whole ships' waste management process, in fact none of its personnel participates in the waste receiving procedures, thereafter they do not obtain a full picture of the situation, thereby are unable to avert potential risks. Fact, which could after all, partly explain the high percentages of marine pollution, even in protected sea zones. Respondents also indicate poorly qualified personnel. But they highlight that the main responsibility lies with the state and not with the personnel's lack

of willingness to learn and acquiring the proper skills. However, whatever it is, results in insufficient on board ships' waste management control check-ups. Incomplete data recording and computerization is considered obstacle for the controls carried out, the monitor and improvement of ships' waste management processes, resulting in lack of substantially high quality services. The latter is also, as proven within the framework of this study, obstacle for researches to address the waste matter conclusively. While those circumstances may have fortunately proven adequate for the current port state, things are about to change with the ongoing expansion plan. It is of the authors understanding that the master plan should be revised in order to obtain a fully organized and monitored ships' waste management plan with fast, reliable and efficient operation.

Consistent with the wider literature, recruitment of highly qualified personnel and cooperation between ports for proper and sufficient surveillance of ships' waste discharges highly recommend. Additionally, it is considered that economic incentives concerning reduction in port charges for ships' waste discharges will be proved beneficial to all parties involved; however, it is a subject to further research and investigation. Furthermore an extended research should include estimation calculations using likewise the FSI14 formulas followed by comparison process, while a comparative research among neighboring ports, could potentially highlight additional useful information.

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¹⁴ The IMO Sub-Committee on Flag State Implementation (FSI), reports activities regarding types and amount of wastes generated on board. The results are a set of waste calculation formulas based on empirical values.

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