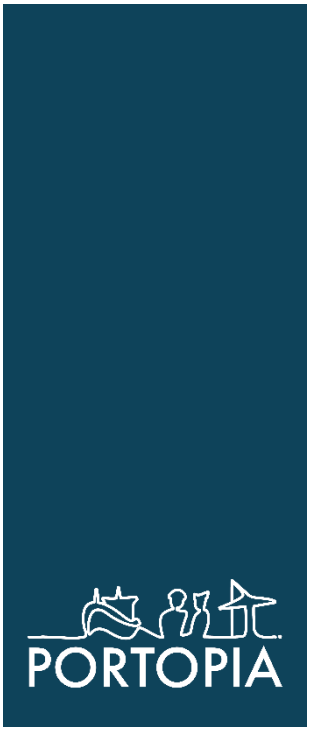

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DELIVERABLE 3.3: INNOVATIVE TOOL FOR INDIVIDUALIZED ENVIRONMENTAL INDICATORS

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DELIVERABLE 3.3: INNOVATIVE TOOL FOR INDIVIDUALIZED ENVIRONMENTAL INDICATORS

1 INTRODUCTION

The present report is the third deliverable (D3.3) of PORTOPIA Work Package 3. Its objective is to present the work done in Task 3.4, entitled *Development of an innovative tool for the identification of specific environmental indicators for individual ports*. This task started in December 2014 (M16) and was due to June 2016 (M34). However, an amendment was made to the Document of Work (DoW) in order to provide more time to test and validate the tool, and therefore it was extended until December 2016 (M40). This deliverable has been prepared by the partner Universitat Politècnica de Catalunya (UPC) (WP3 leader).

The aforementioned Task 3.4 aimed at developing an innovative tool for individualised environmental indicators. This method is called *Tool for the identification and implementation of Environmental Indicators in Ports (TEIP)*. It is a free available and computer-based tool (www.eports.cat/teip) where port environmental managers can access to it, reply a set of questions and then obtain a final list of Environmental Performance Indicators (EPIs) to be used in their port. A set of guidelines for the proper implementation of indicators and recommendations are also provided to the user. In addition, the respondent receives an email with the results, and therefore the outcomes of the tool are kept in the email inbox of the user.

This is a science-based tool that provides a quick calculation and outputs, and it is designed to be as user-friendly and practical as possible in order to facilitate its completion by the user. This new methodology is applicable to all types of ports no matter the size, geographical location or its commercial profile; it provides targeted and specific results for each one. TEIP aims at helping port managers at easily determining their significant port indicators, which provides valuable elements for the decision-making processes.

TEIP tool selects the indicators based on the environmental aspects that are considered significant for the port. Port authorities may already know their Significant Environmental Aspects (SEAs) using their own method or they may use the *Tool for the identification and assessment of Environmental Aspects in Ports (TEAP)* (Puig et al, 2015), a tool developed previously in the framework of the PERSEUS research project (PERSEUS, 2012) aiming at assisting ports in identifying their SEAs. The results of the aspects obtained in TEAP can be taken directly to TEIP for the compilation of indicators. However, if a port has already identified its own SEAs, it can go directly to TEIP.

Deliverable 3.3 is structured in eight parts. Initially an introduction to the report, then the concept, classification and importance of indicators are defined. Thirdly the requirements from the main Environmental Management System standards on indicators are established. After this, a research on the state of the art on indicators' methodologies is presented, followed by a section justifying the need for the tool. Then, the steps that have been undertaken for its development are explained, followed by the validation procedure, together with the final screenshots of the resulting interface. Finally, some conclusions are drawn.

2 ENVIRONMENTAL INDICATORS

One of the first definitions of environmental indicators was provided by the OECD (1993): "environmental indicators are instruments which evaluate the positive or negative state of the environment and the consequences of applied measures". An updated definition was provided by the UN (1995) as "an information tool that summarises data on complex environmental issues to show overall status and trends of those issues".

Indicators are developed and used predominantly to highlight the performance of a biological, physical, chemical, environmental, economic or social system (Jakobsen, 2008). In the case of environment, Environmental Performance Indicators (EPIs) concern an organisation's impacts on living and non-living natural systems, including ecosystems, air, water, soil and sediment (Dantes, 2003).

The purpose of the indicators is to assist in the understanding of the environmental impacts of the port, to know if the operational control of the environmental aspects is effective and if the applied environmental management achieves a good environmental performance. To sum up, an EPI is a parameter that provides information and describes the state of the environment.

In order to evaluate environmental performance of port authorities and to track progress towards continuous improvement, relevant EPIs may be utilised (Donnelly et al., 2007). In this way, port authorities can demonstrate compliance and continuous improvement through scientific evidence and quantifiable measures.

Classification

Since the information provided by the indicators is broad and diverse, it is required to classify them into different categories. There exist several models for organizing the indicators, which are detailed below.

In general terms, indicators may be classified between qualitative and quantitative. The indicators of the first category express presence or absence (Yes/No) of something, whereas the ones of the second category express a value, such as distance, weight, or amount.

At the same time, the standard ISO 14031 Environmental Performance Evaluation (ISO, 1999) identifies five types of quantitative indicators, defined in terms of the basis of their calculation, namely i) direct, ii) relative, iii) indexed, iv) aggregated and v) weighted. According to ISO 14031 (1999), direct (absolute) indicators provide 'basic data or information', such as the emissions of a contaminant. This is the primary form of data for all the indicators and the one in which most of them are expressed. Relative (normalised) indicators provide 'data or information compared to or in relation to another parameter', such as the emissions of a contaminant per tonnes of cargo handled in the port. Indexed indicators describe 'data or information converted to units or to a form which relates the information to a chosen standard or baseline', such as the emissions of a contaminant in the current year expressed as percentage of those emissions in a baseline year. Aggregated indicators provide 'data or information of the same type, but from different sources collected and expressed as a combined value', such as the emissions of a contaminant from all facilities in a given year. Weighted indicators provide 'data or information modified by applying a factor related to its significance'. An example could be an

environmental management index of key EMS components, obtained from the weighting attached to each one.

ISO 14031 (ISO, 1999) states that the use of relative, indexed, aggregated and weighted indicators instead of the direct ones can show a deeper insight by certified companies for the evaluation and monitoring of their environmental performance (ISO, 1999).

Looking more specifically into EPIs, the same standard (ISO 14031) defines three categories of indicators that can be used to support environmental management: i) Management Performance Indicators (MPI); ii) Operational Performance Indicators (OPI); and iii) Environmental Condition Indicators (ECI).

Management Performance Indicators provide "information about the management efforts that influence the environmental performance of the port" (ISO, 1999). They may be seen as qualitative measures of a port authority's capability to deliver environmental protection and sustainability, and as an effective way in which to demonstrate an authority's credentials, competences and programmes to manage a wide range of environmental issues. ISO 14031 (1999) distinguishes four main sub-categories of MPI: implementation of policies and programmes, conformance, financial performance, and community relations.

Operational Performance Indicators provide "information about the environmental performance of the port's operations" (ISO, 1999). They take into account issues related to an organisation's operations, including activities, products or services. For instance, OPI include input indicators such as raw materials, energy and water consumption, and output indicators such as Carbon Footprint, noise, or waste management. Port development operations are also included in this category.

Environmental Condition Indicators provide "information about the local, regional, national or global condition of the environment" (ISO, 1999). This information may help port environmental managers to better recognise the potential impacts that may interact with the environment, and consequently, assist in the planning and implementation of environmental performance evaluation. These indicators analyse the quality of the air, water, soil and sediment. It also includes ecosystems and habitats indicators that show the status and the trends in specific flora and fauna species.

In general, management indicators tend to be qualitative (expressing presence or absence of a range of environmental management elements); and operational and condition indicators are likely to be quantitative (expressing data on the performance and condition of the environment).

Environmental indicators also can be classified as lagging and leading indicators (GEMI, 1998). On one hand, lagging indicators are considered as 'end-of-process' because they are mainly used to report processes' outputs. Although they tend to be quantitative and easy to measure and understand, they are hard to change, basically because they provide data from past events. Lagging indicators are generally preferred by the public and regulators. Examples of lagging indicators are the number of fines or complaints obtained or the amount of toxic contaminants released to air, water or soil. On the other hand, leading indicators are considered as 'in-process' because they try to predict future events or tend to change ahead that event. They usually are qualitative indicators and can be difficult to quantify and evaluate. Examples of leading indicators are the number of environmental compliance audits conducted during a year or the existence of an

environmental policy. A balanced and realistic combination of both, lagging and leading indicators, are essential towards a more effective measurement of the performance. Therefore, both types of indicators are highly recommended to be used in ports.

Another classification of indicators was proposed by the Organisation for Economic Co-operation and Development (OECD), classifying them as pressure, state and response indicators (OECD, 1993). Pressure indicators describe impacts from human activities exerted on the environment. Examples of indicators are noise emissions and consumption of natural resources. These impacts may affect the state of the environment. State indicators are designed to give an overview of the situation concerning the environment and its development over time. Examples include air and water quality indicators. Response indicators are the ones that provide a response to these changes and concerns through environmental, economic and sectoral policies and through changes in awareness and behaviour. Examples of indicators include the categories of environmental complaints and environmental legislation.

Potential users of EPIs

Nowadays, indicators are widely used worldwide in many sectors by a wide range of actors, such as scientists, governments, private-sector companies, public entities or the general public. However, it was not until the early 1990's when international organisations, such as the Organisation for Economic Co-operation and Development (OECD), the World Health Organisation (WHO), the World Bank or the United Nations Environment Programme (UNEP), began to promote the monitoring and reporting of indicators, firstly in the field of economics and right after in the field of environment. Examples of the initial environmental guidelines, technical papers or reports edited by these organisations were: *Environmental indicators. A preliminary set* (OECD, 1991); *Scanning the Global Environment: A framework and methodology for integrated environmental reporting and assessment* (UN, 1995); and *Performance Monitoring Indicators Handbook* (World Bank, 1996). Subsequent improved editions of these documents have been published.

In addition, indicators are used by multi-national agencies such as the Commission for Environmental Cooperation of North America (CEC) and the European Environment Agency (EEA); and in national as well as municipal agencies. Examples of publications from national organisations containing indicators are *UK Biodiversity Indicators in Your Pocket 2010* (DEFRA, 2010); *Environmental Performance Indicators Guideline for Organisations* (Japan Government, 2003); or *Summary of Proposed Indicators for Terrestrial and Freshwater Biodiversity* (Ministry for the Environment of New Zealand, 1999).

Within the port sector, potential users of environmental indicators include a wide range of stakeholders. A port stakeholder is defined as any individual or group having an interest or being affected by port activities (Notteboom and Winkelmans, 2002). Port stakeholders may be very varied and involve a wide range of interested parties. Notteboom and Winkelmans (2002) identified four main stakeholder groups in a port community, all them potential users of indicators: i) internal stakeholders, which belong to the port authority organisation, such as port managers, employees, public relations, board of directors, and unions; ii) external stakeholders, which include companies and industries that invest in the port area, such as customers, terminal operators, shipping agencies, industrial or shipping repair companies; iii) policy and legislation stakeholders, including

departments responsible for transport, economic and environmental affairs on a local, regional, national and supranational level; and iv) community stakeholders, which consist of civil society organisations such as non-governmental organisations (NGOs), local inhabitants, the press, environmentalist groups, and other non-market players. Apart from these mentioned stakeholders, other users of indicators include auditors, banks, insurance companies, sector organisations, and other port national or regional associations.

Importance of environmental indicators

Indicators are increasingly being developed and used as management tools to address environmental issues (e.g. Belfiore, 2003). The use of indicators is strongly recommended due to several reasons. Firstly, indicators monitor progress and provide a picture of trends and changes over time (e.g. Lehane et al., 2002). The second reason is that indicators provide simplified data that not only show clearly how an individual authority is performing, but also assess the national and regional benchmark performance of the sector (De Leffe et al., 2003). Thirdly, indicators may be used to evaluate the effectiveness of policies implemented, by measuring the progress towards environmental targets (e.g. DEFRA, 2003) and to provide a firm basis for future objectives (Dantes, 2003). In addition, they have a key role in providing early-warning information, capable of serving as a signal in case the situation is getting worse, indicating risk before serious harm has occurred (De Leffe et al., 2003). Finally, environmental indicators may be used as a powerful tool to raise public awareness on environmental issues (Gautam and Singh, 2010).

Adopting the culture of using and reporting environmental indicators brings benefits and added value to individual ports, national ports associations, ESPO, the European Commission and other stakeholders. Although indicators are widely used in a large range of different sectors and are generally regarded as being useful in assessing environmental information and solving environmental problems, they do have challenges and limitations. Table 1 summarises the major strengths that the use of indicators brings to a port authority and the weaknesses that indicators have.

One of the major advantages of using indicators, as seen in this table, is that they provide enough information that allows the users to know whether the organisation is in compliance with the allowed legal parameters. EPIs are also helpful for the identification of environmental risks and assist in the reduction of costs. On the contrary, there are still some challenges faced in the implementation of EPIs, mainly related to the simplicity of the indicators (and the difficulty of describing the environment in just some parameters), the limited data availability that may exist or the sensitivity that some indicators can demonstrate at short-term environmental changes.

Table 1: Strengths and challenges of EPIs (De Leffe et al., 2003).

STRENGTHS	CHALLENGES
Compliance with legislation: indicators may provide an appropriate response to legislative and regulatory pressures.	**Sensitivity:** some indicators may be sensitive to short-term environmental changes.
Cost and risk reduction: indicators may identify environmental risks and help to reduce costs (e.g. energy efficiency).	**Data availability:** sometimes the information for most suitable indicators is not available, that makes data less representative.

Sustainable development: indicators may contribute to the continual minimization of environmental impacts, to a better management of environmental issues and to raise staff awareness.	**Simplicity:** indicators are simplifications of observations and sometimes they cannot describe all aspects of every environment.
Market opportunity: indicators may be helpful to meet customer demands, improve relations with customers and they may give a marketing advantage.	**Feasibility**: Although quantitative indicators usually are more representative than qualitative, they tend to be more demanding in terms of time and costs
Positive image: using indicators may show transparency of actions, improve stakeholder relationships and increase confidence of investors, shareholders, banks and insurers.	**Interpretation:** some indicators may be interpreted in different ways, depending on the conditions of the environment.

The use of Environmental Performance Indicators has been continuously encouraged by ESPO among its members. It was initially suggested in the *ESPO Code of Practice 1994* (ESPO, 1994), the first European ports' code of practice of its kind. Later on, the updated *Environmental Code of Practice 2003* (ESPO, 2003) reiterated the importance of identifying EPIs and carrying out environmental monitoring. This Code set out 10 recommendations which the EU port sector was encouraged to follow, being one of them "to promote monitoring, based on environmental performance indicators, in order to measure objectively identifiable progress in environmental port practices" (ESPO, 2003). The use of indicators has also been reaffirmed in the ESPO Green Guide (ESPO, 2012).

Next section researches actually the requirements that the three EMS standards request with regards to them.

3 REQUIREMENTS ON INDICATORS FROM THE EMS STANDARDS

Indicators are used within management systems to measure and report the environmental performance of an organisation, since they contribute to the compulsory evaluation of the environmental aspects and they supply quantitative information on the performance of the organisation (Perotto et al., 2008). For this reason, indicators are key elements that are able to verify whether the objective of continual improvement is carried out or not in an organisation.

Figure 1 demonstrates that the establishment of EPIs (highlighted in red) is a key step in the process of developing an environmental performance evaluation. As it can be seen, it interacts directly with several elements of an EMS.

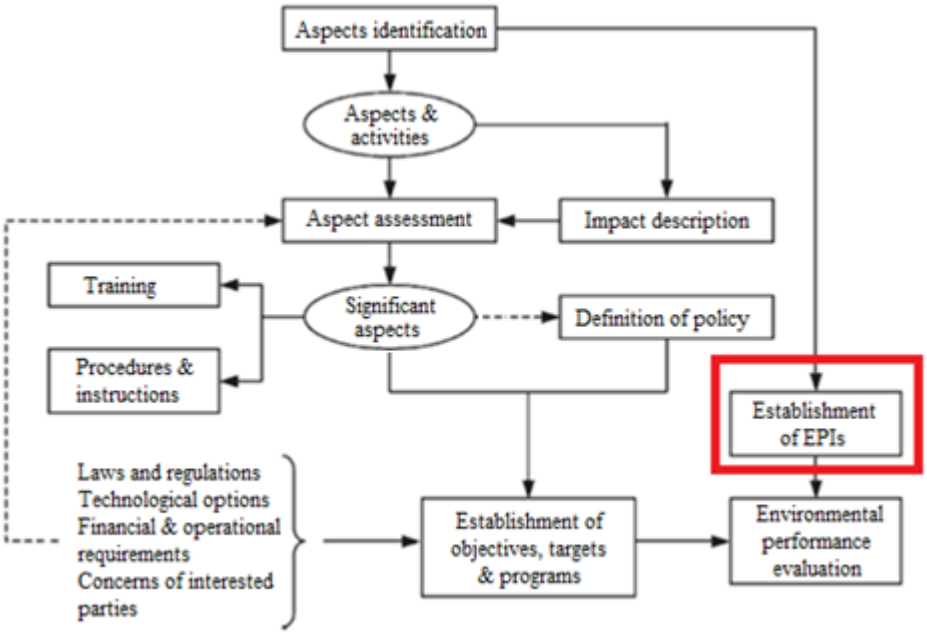

Figure 1: Relations between aspects, indicators and other EMS components (Zobel and Burman, 2004).

The previous figure shows that the analysis of the activities and their associated aspects of any organisation may conduct to the identification and description of the environmental impacts that are generated. The study of these impacts contribute to the assessment of these aspects and to obtain the list of SEAs of the organisation. As a result, the environmental policy of the organisation should be defined taking into account the significant aspects. These aspects together with the mentioned policy form the basis for establishing the set of environmental objectives and targets of the organisation. The Environmental Performance Indicators (EPIs) that are established should be derived from the identified aspects. These indicators, together with the objectives and targets, allows an organisation to develop an evaluation of the environmental performance.

The EMS in the port sector are mainly implemented following the specifications proposed by the standards of ISO 14001 (ISO 2015), EMAS (EC, 2009) or PERS (ESPO, 2011). This section reveals the specific information and requirements regarding environmental indicators that are provided on these three main standards.

3.1 ISO 14001 (2015)

According to the standard, the organisation should establish and maintain a procedure to monitor and measure the key characteristics of its operations that can have a significant environmental impact and a procedure for periodically evaluate compliance with legal requirements (ISO, 2015). The way to do so is through indicators. There are two main sections in the ISO 14001 that imply the use of indicators: 'monitoring and measurement' and 'evaluation of compliance'.

ISO 14001 does not provide any specification in terms of examples of indicators or methodologies for their implementation. However, there is one concrete standard, ISO 14031 (ISO, 1999) on environmental performance evaluation and belonging to the ISO 14000 family, which provides examples of indicators to be implemented.

3.2 EMAS (2009)

EMAS standard recognises that the reporting of the environmental performance should be on the basis of generic and sector-specific performance indicators. This would assist organisations in comparing their environmental performance both over different reporting periods and with the environmental performance of other organisations (EC, 2009). The standard remarks that EPIs should be developed through information exchange and collaboration between Member States.

Annex IV of the standard provides the specifications for the environmental reporting. Since reporting should provide data on actual impact, it should be based on relevant existing EPIs, which are, at the same time, associated with the environmental aspects of the port.

The standard also mentions some characteristics that the indicators should comply. Among others, the standard specify that indicators should give an accurate evaluation of the port's environmental performance, be understandable and unambiguous, or allow for comparison with sector, national or regional benchmarks (EC, 2009).

EMAS protocol gives a list of nine core indicators distributed on six key environmental areas, namely material and energy efficiency, water, waste, biodiversity and emissions. Although these core indicators are highly recommended for use and report, the standard is flexible and states that 'where an organisation concludes that one or more core indicators are not relevant to its significant direct environmental aspects, that organisation may not report on those core indicators, but it shall provide justifications to that effect with reference to its environmental review' (EC, 2009).

3.3 PERS (2011)

The Port Environmental Review System (PERS) protocol also gives importance to the identification of performance indicators, existing one specific clause on this issue. According to PERS (ESPO, 2011), the port should identify from five to ten EPIs relevant to the major environmental aspects and to the policy of the port in order to facilitate

monitoring of the environmental performance. The standard provides around 20 examples of environmental indicators likely to be monitored in port areas.

In addition, the 'environmental report' section of the protocol states that one of information requirements of the report is providing an overview of the major environmental aspects, impacts, and port's performance on these issues. Ports that apply PERS certification for the first time may choose to give a qualitative summary on the actual performance. However, ports that apply for re-certification of PERS are obliged to give more detailed information on their environmental performance, based on the results of their monitoring of Environmental Performance Indicators (ESPO, 2011).

To sum up, PERS protocol encourages more than ISO the use of EPIs, since PERS standard contains one specific requirement concerning indicators and a large number of examples of EPIs are provided. EMAS suggests nine indicators although it is flexible. Although all three standards require a method for selecting indicators, any standard does not mention how each port should select its indicators. For this reason, in the next section the results of a research conducted on the existing methods within the EU port sector is presented.

4 STATE OF THE ART ON INDICATORS' METHODOLOGIES

Although standards require that a set of indicators should be selected in order to monitor their environmental performance, they do not provide any specific guidance to which indicators use. This section researches on the already existing methods used for the identification and assessment of indicators.

A research has been conducted on the existing methods for the identification and assessment of indicators. The methods that have been found are presented below classified in two groups: the methods that have been developed focussed on the whole port sector; and the methods that are used in individual ports.

a) Port sector's methods

An example of a procedure was found in the port sector that explains a methodology proposed to obtain a system of indicators. It is a method that was developed as a result of the research project INDAPORT (2002–2004). This project aimed at establishing systems of indicators in order to implement a sustainable environmental port management (Peris-Mora et al., 2005). The research pathway included the identification of 21 port activities that were applicable to the case study of the Port of Valencia, which were submitted to environmental analysis. Each activity was described through a steps-diagram process, which allowed the identification of inputs and outputs environmental aspects affected by these activities – processes. A cross matrix of aspects and activities, where the activities were shown in the columns and the aspects in the rows, permitted the identification of the most relevant impacts from activities. Experts' panel was used in order to find out which were the most significant impacts. Finally, as a result of the described methodology, 17 selected port system indicators were provided.

b) Individual ports' methods

A research on the current methodologies used in ports to identify indicators was also carried out. The sample considered 51 EU ports, 39 non-European ports, 13 port operators and 17 marinas. In addition, 25 worldwide organisations were also studied. The results of this indicator's research are presented in Annex I. The research considered three possible responses, each one associated to a colour. The results coloured in green mean that the list of indicators and the methodology are provided; in yellow only the indicators are provided and in red neither the list of indicators nor the methodology.

Within the sample of the EU port authorities, the research demonstrated that a large number of ports publish the list of indicators that they use (37 out of 51); however, just a few explain the origin of these indicators (10 out of 51). In all these 10 cases, the sources of the indicators were standardised lists of indicators, such as the ones provided by the Global Reporting Initiative (GRI, 2013) or by the EMAS standard (EC, 2009). Particularly, the port authorities of A Coruña, Antwerp, Ceuta, Bremen, Hamburg, Stockholm and Rotterdam use the GRI proposal; the Port Authority of Livorno use EMAS standard guidelines; the Port Authority of Valencia use EMAS and GRI, and finally the Port Authority of Cartagena use EMAS and particular legislation.

In the non-EU port authorities, the results are less encouraging. Although there are 26 ports that mention and publish the list of indicators, only one port provide the source and the resulting indicators. This is the case of the port of Singapore, which uses the GRI guidelines.

With regards to port operators, 38.5% of them provide the list of indicators and 30.8% the methodology. In particular, Cosco Group and Maersk Group are using the GRI and the Terminal de Contenidors de Barcelona (TCB) and the Terminal de Contenedores de Gijón (TCG) are using EMAS as a method to obtain a set of indicators to monitor their performance.

In terms of marinas, there is a higher percentage (47%) of ports that publish both the indicators and the methodology. In this case, all the marinas follow the methodology suggested by the EMAS standard (EC, 2009), as sources of indicators.

The sample of the 25 international port organisations included a worldwide organisation (International Association of Ports and Harbours) and then two organisations from Oceania, nine from Europe, eight American organisations, three from Asia and two from Africa (see table 5.5). Unfortunately, any of the organisations provided its methodology for the identification of indicators.

5 THE NEED FOR A TOOL

The benefits and importance for identifying environmental indicators have been detailed previously in this report. Several reasons have been provided which demonstrate that they are key elements of the whole environmental management of a port.

As mentioned before, ISO 14001, EMAS and PERS specifications require the use of Environmental Performance Indicators, although they do not specify which particular indicators use. Some examples of EPIs are provided by the standards, although the final decision relies on each individual port, in accordance with their significant aspects. The same happens with the standard ISO 14031 (ISO, 1999), which provides examples of different indicators from which each company can make its own selection. This standard recognises that it is not possible to provide a single set of universally relevant indicators because of the diversity of organisations and their policies, objectives and structures. Although it states that the organisation should select indicators for environmental performance evaluation that are recognised as important, it does not provide any clear guidance or criteria by which each organisation could make its own selection.

In the research of the existing methodologies in the sector, only one procedure was found explaining how to create a system of indicators. In addition, the research demonstrated that this procedure is currently no longer used by ports. The research on individual ports made evidence that a wide range of ports use EPIs, but just a few explained the reason for using that set of indicators.

In addition, the *European Port Industry Sustainability Report 2016* revealed that 66% of the respondent ports have identified environmental indicators to monitor trends in environmental performance (ESPO, 2016). Nevertheless, when ports were asked to name the environmental indicators used, the responses provided almost 100 different indicators. This wide range of indicators means that although ports are becoming increasingly aware of the benefits of using environmental indicators, there is not a common approach as to which indicators adopt. If ports are not using a procedure to identify indicators, it may well be that the selected indicators are not the most appropriate.

These reasons have contributed to identify the need for the creation of a common method that assists ports in identifying indicators in a more reliable manner. As mentioned before, even if each port is different, having a standard methodology that can provide specific results for each port is desirable to mutual advantage of sector and individual ports. As a consequence, an interactive tool has been created aiming at proving a set of performance indicators especially selected for the port user and which is based on the Significant Environmental Aspects (SEAs) of the port, as well as other port characteristics. The method has been developed specifically for the port sector and it is valid and publicly available for any port authority, including sea ports and inland ports. The development of the tool is explained in the following section.

6 DEVELOPMENT OF THE TEIP TOOL

The steps followed for the development of the TEIP tool are schematised in figure 2 and explained in the paragraphs below:

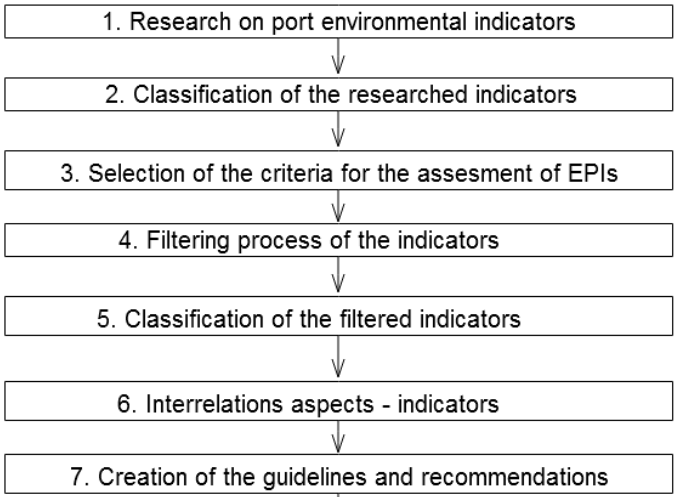

Figure 2: Steps carried out for the development of TEAP

6.1 Research on port environmental indicators

It has been observed that there is a wide range of studies that confirm that ports report their performance through the use of Environmental Performance Indicators (EPIs). An extensive research has been carried out in order to identify and compile a very broad inventory of EPIs that are being used and reported in the industrial sector, with especial emphasis to the port sector. A vast list of references was researched, and each single new indicator that was identified within these references was added to the inventory, which contains a total number of 648 different indicators. It may be considered as the largest compilation of environmental indicators for the port sector that is known.

The final list of indicators, along with their sources, are provided in the Annex II of this report. Eleven different sources of information were used, being these ones classified in eight categories, listed in table 2:

Table 2: Sources of information used for the identification of indicators

Categories	Sources	
Global Reporting Initiative (GRI)	Global Reporting Initiative (GRI)	
Research projects	ECOPORTS	EPI ECOPORTS
		Self-Diagnosis Method (SDM)
	INDAPORT	
	PPRISM	
ESPO Questionnaire	ESPO Questionnaire	
Research studies	Research studies	
Legislation	Legislation	

Port environmental reports	Port environmental reports
Port organisations	Port organisations
EMS standards	EMS standards

In the paragraphs below, the different categories are explained, as well as the type and the number of indicators found in each one.

i) Global Reporting Initiative

The Global Reporting Initiative (GRI) is a non-profit organisation, founded in 1997, that promotes sustainability reporting as a way for organisations to contribute to sustainable development (GRI, 2015a). Although the GRI is an independent organisation, it collaborates with the United Nations Environment Programme (UNEP) and works in cooperation with the United Nations Global Compact (UNGC).

GRI develops and disseminates globally applicable Sustainability Reporting Guidelines for voluntary use by organisations, reporting on the economic, environmental, and social dimensions of their activities, products and services (ACCA, 2001). In 1999, an 'exposure draft' of these Guidelines was released, and in 2000 the full version was completed (ACCA, 2001). Four further revisions of these guidelines have been carried out, in order to provide the best and most up-to-date guidance for effective sustainability reporting. The second revision was launched in 2002 (GRI, 2002), the third generation (referred to as the GRI G3 Guidelines) was released in 2006 (GRI, 2006) and, finally, the fourth update (known as G4) was presented in 2013 (GRI, 2013).

GRI Guidelines are widely used worldwide. In 2015, more than 5,000 organisations used these guidelines for their sustainability reporting across more than 90 countries; more than 20,000 reports were registered in GRI's Sustainability Disclosure Database and 23 countries reference the Guidelines in policies (GRI, 2015b). These Guidelines may apply to corporate businesses, public agencies, small and medium enterprises, NGOs, industry groups and other organisations.

Environmental transparency is one of the main priorities of the scope of the GRI, so that the users of these Guidelines are encouraged to report on their environmental performance. To facilitate the reporting, the latest Guidelines (G4) suggest the monitoring of a set of Environmental Performance Indicators (EPIs), covering impacts related to inputs (such as energy and water) and outputs (such as emissions, effluents and waste). In addition, it covers biodiversity, transport, and product and service-related impacts, as well as environmental compliance and expenditures. A total number of 44 indicators have been included in the present inventory.

Apart from providing the Guidelines applicable to all types of companies, the GRI has developed Sector Supplements, allowing them to report according to their specific needs. For instance, in 2011, a report on the GRI Guidelines exclusively for the airport operators sector was released (GRI, 2011). Since environmental matters are significant concerns for airports and their stakeholders, several amendments were made to the G3 Guidelines to make them more applicable to this sector. Noise was considered as the main environmental concern from the airport sector that was not addressed by the GRI Guidelines, and for this reason, it was included as a new aspect in this airport supplement. However, from this report any additional indicator was obtained for the current research.

Unfortunately, this specific GRI guidance has not yet been developed for the port sector. Nevertheless, a study from Maigret (2014) investigated the current state of sustainability reporting in the port sector, by studying the GRI G3 environmental indicators that could be included or deleted for the development of a Sector Supplement, and providing potential additional indicators not covered under G3. These indicators have been taken also into consideration in the present research, although all they were already included in the database obtained from other sources.

ii) Research projects

The EU port sector has undertaken several research projects aimed at developing practical tools and methodologies to assist port managers to deliver compliance with legislation and to implement best practices in environmental management (Wooldridge and Stojanovic, 2004). There is no doubt that the development of these research projects contributed to enhance further the research cooperation between the port industry on one hand and the academia and research institutes on the other.

In addition, the development of several research projects has contributed to define and consider sets of environmental indicators for ports. In this research, the outcomes of major international and collaborative research projects have been examined, namely ECOPORTS (2002-2005), INDAPORT (2002-2004), PEARL (2005-2008) and PPRISM (2010 - 2011).

Firstly, in the framework of the ECOPORTS project there were two major outcomes that provided performance indicators for ports. The first one consisted of a document that compiled a set of 56 indicators. The second outcome was the Self-Diagnosis Method (SDM) (Darbra et al., 2004). The SDM is a questionnaire that aims at providing an overview of the environmental situation and performance of the respondent ports. It contains a set of Yes / No questions that can be considered as qualitative environmental management indicators and, as a consequence, they have been taken into account for this research. A total number of 65 useful environmental indicators were provided in the field of management performance. This method was designed to help port environmental managers to continuously assess their performance and the progress achieved through time.

The methodology followed for the selection of indicators in the project Port Environmental Indicator System (INDAPORT) concluded with a final list of 17 indicators, obtained as a result of a research of the port activities and impacts in the Port of Valencia (Peris-Mora et al., 2005), already included in the final list.

With regards to PPRISM project, a comprehensive inventory of more than 300 existing EPIs in use in the seaport sector was identified for monitoring performance of operational, managerial and environmental condition. These indicators were filtered against specific criteria and were assessed and evaluated by port stakeholders in order to obtain a final set of indicators suitable to be implemented at EU level. In this research, all the 311 indicators identified within PPRISM have been included in the compilation.

The project PEARL studied the main environmental monitoring needs of ports. The resulting needs were related to marine issues (information on currents, waves and tides), water quality (the monitoring of different parameters such as salinity, water temperature, nutrient levels and dissolved oxygen), and meteorological parameters (data on atmospheric pressure, humidity, rainfall and temperature from meteorological stations

located throughout the port area). Although this research did not provide any additional indicator to the compilation, it was useful to ensure that a wide range of indicators was already taken into account.

iii) ESPO Questionnaire

A very important source of indicators for this research has been the results obtained in the *ESPO/Ecoports Port Environmental Review 2009* (ESPO, 2010). This questionnaire asked whether the port authority had identified environmental indicators to monitor trends in environmental performance and, if so, to name the indicators used. This allowed the researchers to have feedback from 122 ports of 20 different European Maritime states, obtaining a total number of 95 port environmental indicators. Data collection benefited from the development of a web based tool that facilitated online submission by interested ports and improved analysis and interpretation of results. The indicators obtained in this questionnaire have been incorporated in this compilation list, although the individual sources were kept anonymously.

iv) Research studies

The literature review demonstrated that there is a wide representation of research studies that provide environmental indicators. For the focus of this thesis, both, research reports carried out within the port sector and other studies not strictly related with ports were studied.

On one hand, reports related to ports were analysed in detail: the report prepared by the Postgraduate Course in Environmental Management (EPCEM) in the courses 2002 -2003 (De Leffe et al., 2003) and 2004-2005 (Berends et al., 2005), the research developed by Osorio and Quintana (2010), and a report carried out by the Economic and Social Commission for Asia and the Pacific (ESCAP) (UN, 1992). As a result the first report, called *Environmental Performance Indicators in European Ports*, a collection of 115 EPIs for ports was established, based mainly on a research of eight European port authorities. The second report was titled *Evaluation of Environmental Performance Indicators for European Ports & Impacts of the ECOPORTS Project* and developed a set of guidelines containing 49 validated EPIs for use in European ports. The research developed by Osorio and Quintana (2010) identified 128 indicators based on an analysis of nine Colombian ports, classified in six categories: water quality (61 indicators), sediments quality (29), soil quality (8), air quality (7), biology (14), social indicators (9). The last report, called *Assessment of the Environmental Impact of Port Development. A Guidebook for EIA of Port Development*, proposed 16 water related indicators, 14 bottom contamination indicators, and 11 air related indicators.

On the other hand, other examples of studies that provide lists of environmental indicators were taken into consideration, although they are not specifically for the port sector. These are the report *OECD Key Environmental Indicators* from the Organisation for Economic Development and Co-operation (OEDC, 2008) that defines 44 environmental indicators; the report *Environmental Performance Indicators Guideline for Organisations (Fiscal Year 2002 Version)* published by the Japan Ministry of the Environment which includes 80 indicators (Japan Government, 2003); the report *Summary of Proposed Indicators for Terrestrial and Freshwater Biodiversity* (Ministry for the Environment of New Zealand, 1999) which proposes 20 biodiversity indicators; or the *UK Biodiversity Indicators in Your Pocket 2010* (DEFRA, 2010) that also proposes 18 indicators related to biodiversity.

Although this source provided a high number of indicators, some of them were repeated in the sources, achieving a final list of 135 different indicators, all them are listed in Annex II.

v) Legislation

International and European legislation has also been taken into account in this study. Research into conventions from the International Maritime Organisation (IMO) as well as directives and other regulations from the European Commission provided further indicators that have been included in the broad inventory. The research on legislation compiled 224 indicators, being some of them overlapped, obtaining a final number of 115 different indicators. Table 3 shows, in a chronological order, the nine international conventions that have been researched, along with the number of indicators that are mentioned in each one. A total number of 50 indicators is provided from international conventions.

Table 3: Number of indicators obtained from international conventions

International conventions	Acronym	Year	Indicators
International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties	INTERVENTION	1969	0
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	London Convention	1972	22
International Convention for the Safety of Life at Sea	SOLAS	1974	0
International Convention for the Prevention of Pollution from Ships	MARPOL	1973 /78	8
International Convention on Standards of Training, Certification and Watchkeeping	STCW	1978	0
International Convention on Oil Pollution Preparedness, Response and Co-operation	OPRC	1990	0
International Convention on the Control of Harmful Anti-fouling Systems on Ships	AFS	2001	2
International Convention for the Control and Management of Ships' Ballast Water and Sediments	BWM	2004	5
International Convention for the Safe and Environmentally Sound Recycling of Ships	Hong Kong Convention	2009	13

The same exercise was carried out for the case of European Directives. The ESPO Green Guide (ESPO, 2012) provides a list of directives that affect ports and environment. A total of 22 directives were researched, obtaining a total number of 168 indicators, as demonstrated in table 4. Out of the 22 directives, only there are five of them that do not provide any EPI.

Table 4: Number of indicators obtained from European directives

European Directives	Reference	Year	Indicators
Conservation of Wild Birds Directive (BIRDS)	79/409/EEC	1979	3
Environmental Impact Assessment (EIA) Directive	85/337/EEC	1985	2
Conservation of Natural Habitats and of Wild Flora and Fauna Directive (HABITATS)	92/43/EEC	1992	1
Volatile Organic Compound (VOC) Emissions Directive	94/63/EC	1994	1
Ambient Air Quality Assessment and Management Directive (Air Quality)	96/62/EC	1996	7
Integrated Pollution Prevention and Control (IPPC) Directive	96/61/EC	1996	25
Waste Incineration Plants Directive (WIPD) Directive	00/76/EC	2000	13
Framework for Community action in the field of water policy (Water Framework Directive)	00/60/EC	2000	28
Port reception facilities for ship-generated waste and cargo residues Directive	00/59/EC	2000	7
National Emission Ceiling (NEC) Directive	01/81/EC	2001	6
Large Combustion Plants Directive (LCP) Directive	01/80/EC	2001	3
Strategic Environmental Assessment (SEA) Directive	01/42/EC	2001	0
Assessment and Management of environmental Noise (Noise Directive)	02/49/EC	2002	15
Community vessel traffic monitoring and information system Directive	02/59/EC	2002	0
Public Access Environmental Information Directive	03/04 EC	2003	0
Emission Trading System (ETS) Directive	03/87/EC & 09/29/EC	2003	3
Environmental liability with regard to the prevention and remedying of environmental damage (Environmental Liability Directive)	04/35/EC	2004	0
Sulphur content of marine fuels Directive	05/33/EC	2005	2
Marine Strategy Framework Directive	08/56/EC	2008	8

Environmental quality standards in the field of water policy Directive	08/105/EC	2008	35
Waste Framework Directive	08/98/EC	2008	0
Eco-Management and Audit Scheme (EMAS III)	1221/09/EC	2009	9

Apart from the above-mentioned international conventions and European Directives, there are other six European regulations affecting ports and the environment, provided in table 5, which have also been considered. From these regulations, six indicators were obtained.

Table 5: Number of indicators obtained from other European regulations

Other European regulations	Reference	Year	Indicators
Pollution from ships (COSS) Regulation	2099/2002	2002	0
Regulation on Shipment of waste	1013/06/EC	2006	0
Green House Gases Decision	406/09/EC	2009	1
Maritime Spatial Planning	--	2010	2
Integrated Coastal Zone Management	--	2011	0
Estuary guidelines	--	2011	3

vi) Port environmental reports

This source includes an evaluation of numerous environmental reports and reviews from a large number of port authorities. Usually, when a port authority makes efforts towards the environment, it is keen to show it and publish its performance for its stakeholders. Most of the port authorities that publish an environmental report make it publicly available in their website and they tend to update it annually.

A research on the provision of indicators from the organisations used in section 4 of this deliverable (51 European port authorities, 39 non-European port authorities, 17 marinas and 13 port operators) was also conducted. Annex I provides the names of the organisations with the number of indicators reported in each one, along with the name of the document that provides this information. Although a total number of 1360 indicators were compiled only from this source, many indicators were repeated and reported several times by numerous ports. For instance, the monitoring of SO_2 emissions is a very common indicator and it appeared regularly in the reports. This allowed to reduce it to a shorter list of 282 different port environmental indicators, which were added into the inventory (see Annex II), in case they were missing.

vii) Port organisations

The indicators suggested for monitoring by international port organisations also were taken into consideration. Although most of the researched port organisations make reference to environmental protection and sustainable development, only very few currently provide a list of EPIs to recommend to their port members. Most of the common actions that these organisations suggest are the development of an Environmental Management System (EMS) and the monitoring of the environmental performance. The

associations that have been reviewed and the number of indicators found in each one are showed in table 6 below. The research included both national and regional port organisations, from all the five continents, as well as the International Association of Ports and Harbours (IAPH) from a worldwide perspective.

Table 6: Number of indicators obtained from port organisations

Continent	Organisation	Indicators
Worldwide	International Association of Ports and Harbours (IAPH)	26
Oceania	Ports Australia	3
	Papua New Guinea Ports Corporation (PNG ports)	0
Europe	European Sea Ports Organisation (ESPO)	0*
	Baltic Ports Organisation (BPO)	17
	Puertos del Estado (Spanish Ports)	35
	Associated Danish Ports (ADP)	0
	Union des Ports de France (UPF)	0
	British Ports Association (BPA)	1
	Finnish Port Association	0
	Bulgarian Ports Infrastructure Company	0
	Ports de la Generalitat (Catalan Ports)	5
America	Ports America	0
	American Association of Port Authorities (AAPA)	0
	U.S. States & Ports Association (USSPA)	0
	Association of Pacific Ports (APP)	0
	American Great Lakes Ports Association (AGLPA)	3
	California Association of Port Authorities	0
	Gulf Ports Association of the Americas	0
	Association of Canadian Port Authorities (ACPA)	0
Asia	China ports	0
	Indian Ports Association (IPA)	0
	Association of South East Asian Nations ports association (ASEAN)	0
Africa	Port Management Association for West and Central Africa (PMAWCA)	0
	Port Management Association of Eastern and Southern Africa (PMAESA)	0

* Although ESPO does not propose operational performance indicators, this organisation propose indicators regarding environmental management through the EcoPorts tools of SDM and PERS, which are fully integrated in the ESPO structure since 2011 (see section 5.1 for more information).

The International Association of Ports and Harbours (IAPH) has an entire branch dedicated to the environmental management, titled World Port Climate Initiative (WPCI). Among the different initiatives conducted by this organisation, a set of 26 performance indicators are proposed and included in the current compilation list.

As demonstrated in table 6, the number of indicators provided by each organisation vary between them, obtaining a total number of 90 indicators from this source, being different 61 of them. In the case of the organisations that does not report any indicator, on the basis alone of this research, it cannot be concluded that appropriate indicators have not been identified or selected. There may be several reasons why such information is not already in the public domain, such as political, policy, IT, culture, language, or resources available, among others.

viii) EMS standards

Finally, the indicators that are proposed for monitoring in the different EMS standards also were studied carefully. Although it is known that the standards do not oblige the use of any specific indicator, they do suggest several examples of EPIs. This is the case of ISO 14031 document (ISO, 1999), which provides more than 100 indicators. It is a very broad compilation, including indicators that are out of the scope of the port sector because they refer to industrial processes. Therefore, the indicators that were not considered applicable to ports were not included in this research.

The EMAS protocol (EC, 2009) supplies a shorter list of EPIs. This standard provides nine core environmental indicators that are suggested for monitoring and reporting as a tool for sustainable development and continual improvement. The standard recognises that there is flexibility in their application and the organisation may decide not to report on a specific core indicator and may also report on the basis of additional relevant Environmental Performance Indicators. These indicators also were included in the compilation.

The third main standard to establish an EMS in the port sector is the Port Environmental Review System (PERS). This standard provides the list of 30 indicators (ESPO, 2011) as examples of EPIs related to the environmental quality, efforts and effects, which were included in the compilation. Based on the three previous standards, 98 indicators were included in the compilation list.

6.2 Classification of the researched indicators

As mentioned in the previous chapter, Annex II contains all the indicators and the sources of each one. It is interesting to note that several indicators appeared in more than one source, sometimes with exactly the same term and in other cases with similar names. For this reason, it was necessary to review the list and to avoid the repeated indicators.

After this, the literature review led to the creation of an inventory 648 environmental indicators. These indicators were classified under nine categories of indicators. It included seven categories of environmental aspects identified in TEAP tool (Puig et al, 2015) and two more categories were added, concerning environmental management and port development (see table 7).

Table 7: Categories of the researched indicators

Category	Total number
Emissions to air	66
Discharges to water / sediments	83
Emissions to soil	17

Resource consumption	93
Waste production	65
Noise	22
Effects on biodiversity	43
Environmental management	238
Port development	21

The following paragraphs explain the indicators located within each of the previous categories.

Emissions to air

Air quality is a major environmental priority among European ports (ESPO, 2016). This category includes 66 indicators, mostly on the environmental monitoring, divided into six subcategories, as shown in table 8.

Table 8: Number of emissions to air indicators

Subcategory	Number of indicators
Emissions of combustion gases	28
Emissions of other gases	15
Emissions of particulate matter	5
Odour emissions	9
Other emissions	2
Meteorological data	7
Total number of emissions to air indicators	**66**

The subcategory *Emissions of combustion gases* is the one that has more indicators, 28 in total. They are related to the gases emitted during combustion of fossil fuels, and include both qualitative indicators (which mostly refer to footprint and to the efforts to reduce it) and quantitative indicators (which refer to emissions of greenhouse gases). *Emissions of other gases* refers to the monitoring of other air quality indicators, for instance, hydrocarbons or Polychlorinated biphenyl (PCB). The *Emissions of particulate matter* refers to the dust and other particulate matter (PM10 and PM2.5) emissions. The subcategory *Odour* includes indicators related to any release of gas that produces unpleasant smell. *Other emissions* includes the emissions of radiation, heat, vibration and light. Finally, *Meteorological data* includes meteorological indicators (e.g. temperature or wind speed). These last two subcategories were not identified as aspects and, therefore, they have been added.

The main sources of the indicators in this category are the environmental reports conducted by port authorities, the project PPRISM and the European legislation.

Discharges to water / sediments

The contamination of the sediments is also included in this category because any discharge to water may reach the bottom of the sea and then affect the sediments. *Discharges to water and sediments* is divided into five subcategories, as shown in table 9. In total, 83 indicators are included.

Table 9: Number of discharges to water / sediments indicators

Subcategory	Indicators
Discharges of wastewaters	36
Discharges of hydrocarbons	2
Discharges of other chemicals	14
Discharges of particulate matter	4
Sediments quality	27
Total number of discharges to water/sediments indicators	**83**

Discharges of wastewaters has the major number of indicators, 36 in total. It includes water quality parameters, such as the indicators Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), pH and dissolved oxygen. The subcategory of *Discharges of hydrocarbons* collects the indicators related to spills in the port waters of crude oil and other petroleum products. *Discharges of other chemicals* contains the indicators that relate to concentrations of pollutants such as Polycyclic Aromatic Hydrocarbons (PAHs), tributyltin (TBT) and biocides. The fourth subcategory is the *Discharges of particulate matter* and includes four indicators, namely Total Dissolved Solids (TDS), Total Suspended Solids (TSS), settleable solids and turbidity. Finally, the subcategory *Sediments quality*, as its name suggests, covers the indicators identified in the research that relate to the quality parameters of the sediments, such as concentrations of contaminants and physical characteristics of the sediments themselves.

The main source of the indicators in this category are the environmental reports from ports, followed by research studies, the project PPRISM and the European legislation. As seen, most of these indicators aim at monitoring the environmental situation of ports.

Emissions to soil

Soil emissions indicators aim at assessing the past and present emissions made on the soil. A total number of 17 indicators was identified related to this aspect, without being divided into any subcategory. Examples of indicators are the soil pH, water content or the soil porosity. The main source of information of soil emissions indicators has been PPRISM project. The concentration of heavy metals, the soil occupation efficiency, the soil pH and availability of a soil pollution map are the indicators that have been cited by more sources.

Resource consumption

The indicators that have been collected related to the aspects of resource consumption are a total of 93. These are mostly operational indicators, although there are some management indicators. As shown in table 10, this category is divided into five subcategories.

Table 10: Number of resource consumption indicators

Subcategory	Indicators
Energy consumption	25
Water consumption	25
Electricity consumption	14

Fuel consumption	18
Other resources consumption	11
Total number of resource consumption indicators	**93**

Energy and water consumption have the same number of indicators: 25 each one. The first subcategory, *Energy consumption*, includes the indicators compiled that refer to the overall energy consumption in the port (e.g. total energy consumption by source, percentage of annual variation in energy consumption, or consumption of renewable energy). *Water consumption* refers to the indicators related to the amount of water consumed by the port authority or within the port area.

Electricity consumption indicators basically include the power consumption of the port authority and initiatives related to the supply of electricity to ships. The subcategory of fuel consumption refers to indicators related to the amount of fossil fuels consumed in the harbour. Finally, the *Other resources consumption* subcategory includes indicators that refer to the use of consumables such as paper, printer toners or lubricants.

The main source of information of these indicators is the research carried out on environmental reports of port authorities, followed by the project PPRISM and the latest Guidelines for environmental reporting developed by GRI.

Waste production

Ports are characterised for being a key connection point for the traffic of passenger and for hosting a wide range of industrial activities. All these practices may generate a variety of waste, both hazardous and non-hazardous, which ports must manage properly (ESPO, 2012). A total of 65 environmental indicators aiming at management waste production were identified, divided into four subcategories, as shown in table 11.

Table 11: Number of waste production indicators

Subcategory	Number of indicators
Generation of waste	34
Generation of solid urban waste	7
Generation of hazardous waste	14
Generation of other waste	10
Total number of waste production indicators	**65**

Generation of waste includes indicators that relate to waste in a generic way, without distinguishing what type they are. *Generation of solid urban waste* includes indicators regarding waste fractions: organic waste, paper and cardboard, plastics and glass. The following one is dedicated to hazardous waste, which includes oils, batteries and fluorescents, among others. Finally, the subcategory *Generation of other waste* includes non-hazardous industrial waste such as metal, wood, oil filters and electronic waste.

The two main sources of the waste production indicators were obtained from environmental reports conducted by port authorities and from the PPRISM project.

Noise

A total number of 22 indicators were identified related to noise and all of them are classified under the same category. These indicators involve mainly the levels of noise in different time zones and the measures implemented to control and reduce these levels. The main sources of this category are the project PPRISM and port authorities' reports.

Effects on biodiversity

This category includes the indicators related to the monitoring of the fauna and flora inside the port area, the protection of natural habitats and the status of the soil. This category of aspects was not included in TEAP. 43 indicators were identified and classified into a single category, obtained mainly from the PPRISM project and reports from the port authorities consulted (e.g. Port of Valencia or Port of Cartagena).

Environmental management

Environmental management indicators is one of the three categories of indicators, as defined by the standard ISO 14031: Environmental Performance Evaluation (ISO, 1999). This category embraces all the indicators collected that provides information on the issues of environmental management. It has the highest number of indicators, 238 in total, representing a 37% of the total number of indicators collected. Management performance indicators may be allocated into 14 subcategories all related to the efforts made by the port authority towards the implementation of an effective environmental management within the organisation. Most of the subcategories are the components required in the establishment of an Environmental Management System, which are shown in the following table:

Table 12: Number of environmental management indicators

Subcategory	Number of indicators
Environmental Management System	10
Environmental Policy	14
Objectives and targets	10
Environmental Monitoring Plan	8
Significant Environmental Aspects	4
Management organisation & personnel	16
Environmental training and awareness	23
Environmental communication	22
Emergency planning and response	41
Environmental audit	10
Environmental legislation	19
Environmental complaints	15
Environmental budget	25
Other environmental management	21
Total number of environmental management indicators	**238**

Most of these indicators were obtained from the PPRISM project. In this way, from the 238 indicators listed in the management indicators, 132 are provided by this project. It is also interesting to note that from the environmental reports of port authorities, a total number of 65 indicators of management were identified, often being overlapped with indicators from the PPRISM project. The Self-Diagnosis Method (SDM) is also a significant source in this category, contributing with 62 indicators.

Port development

The increase in maritime transport around the world has required the development of ports with the construction of deeper channels and new docks. On land, the lack of space and the increasing number of industries located in port areas may create the need to expand the port towards the surroundings (EcoPorts Foundation, 2004). This category collects the indicators related to the port development, either at sea or on land due to their importance. It includes 21 indicators, grouped under the same category, which refer mostly to dredging operations and the location of dredging sediments. The main source of information of this category is the PPRISM project.

6.3 Selection of criteria for the assessment of EPIs

As it has been demonstrated in the previous sections, a research was conducted and compiled a broad number of existing environmental indicators, almost 650 different EPIs. For this reason, it was found necessary to filter this large amount of indicators to a shorter list, more suitable to be potentially applied in port areas.

In order to carry out this filtering process in a methodological way, each indicator was assessed through a set of criteria. Then, the indicators that complied with more criteria were selected and the ones that obtained a poor performance were rejected. This section aims at defining the criteria used to assess the environmental indicators.

In order to establish the set of criteria to evaluate the extensive number of indicators, a literature review was conducted on the already existing criteria. A total number of 11 different sources were consulted. The nature of these sources was very broad, including scientific articles (Dale and Beyeler, 2001; Peris - Mora et al., 2005; Donnelly et al., 2007); reports from governments (EC, 1998 and Ministry for the Environment of New Zealand, 1999) and from public institutions (EEA, 2005; and UNEP, 2003); reports generated by other agencies (OECD, 1993; and Verfaillie and Bidwell, 2000); on-line publications (Jakobsen, 2008) and even the results of an investigation carried out in the framework of an environmental management course (De Leffe et al., 2003).

From this 11 sources, a set of 84 different names of criteria used to assess performance indicators was obtained. Annex III shows a table containing the criteria and their sources. By analysing these resulting 84 criteria, it was found that although some of them were written differently, the concept and the meaning was the same or, at least, similar. For this reason, the criteria that had the same purpose were grouped under the same name. This process allowed the reduction from the 84 criteria identified in the sources until the final number of 22 criteria. Table 13 below shows this resulting list of 22 criteria, along with their definition.

Table 13: Initial list of criteria to assess the indicators with definitions

Criteria	Definitions
1. Reliable	The source of the indicator is contrasted and scientifically robust
2. Limited	The indicator has well-defined limits and provides information about its own limitations
3. Practical	The indicator is easy to implement
4. Updated regularly	The indicator is determined at regular intervals for the purpose of actively pursue and influence the desired data
5. Understandable	The meaning of the indicator is easy to understand
6. Informative	The indicator enhances the port performance communication
7. Clearly defined	The meaning of the indicator is clear
8. Relevant	The indicator must be oriented and focused on the port priorities
9. Trend representative	The indicator allows to observe trends on the port performance
10. Specific	The indicator takes into account the particularities of the port
11. Measurable	The indicator can be measured in a quantitative way
12. Cost effective	The implementation of the indicator is feasible in terms of time and money with respect to the outcome obtained
13. Comparable	The indicator leads to potential performance comparisons
14. Standard	The indicator is equivalent for a wide spatial and temporal scale/range
15. Progress towards targets	The indicator allows to evaluate an activity in a way that targets linked to objectives are accomplished
16. Legislative priority	The indicator is defined (as a priority) in well-recognized legislations/ directives
17. Sensitive	The indicator is sensitive to the particularities of the system
18. Available	The indicator is available for all the stakeholders
19. Broadly accepted	The indicator is included in most of the sources consulted
20. Anticipative	The indicator predicts potential modifications in the system configuration
21. Integrative	The indicator is a part of a bigger set of indicators which describes a system
22. Adaptable	The indicator is adapted to other indicators, models and prediction systems

The 22 criteria listed in the table above were studied in more detail. It was found that some criteria could be further merged because they represent the same idea, and others could be discarded because they are out of the scope of this research. This second assessment made a reduction from the 22 to 10 criteria. Table 14 shows the ones that were merged, the ones that were kept as they were, and the three criteria that were discarded.

Table 14: Merging process of criteria

Previous criteria	New criteria
1. Reliable 2. Limited	1. Reliable
3. Practical 4. Updated regularly	2. Practical
5. Understandable 6. Informative 7. Clearly defined	3. Understandable
8. Relevant 9. Trend representative 10. Specific	4. Suitable
11. Measurable 12. Cost effective	5. Cost effective
13. Comparable 14. Standard 15. Progress towards targets	6. Comparable
16. Legislative priority	7. Legislative priority
17. Sensitive	8. Sensitive
18. Available	9. Available
19. Broadly accepted	10. Broadly accepted
20. Anticipative 21. Integrative 22. Adaptable	(discarded)

The three indicators that were discarded were *Anticipative* (20), *Integrative* (21) and *Adaptable* (22). Since the focus of this research is to determine useful indicators to assess the current environmental situation and to monitor progress towards targets, the criterion *Anticipative* was refused because it is out of the scope of this research of predicting potential adverse environmental impacts and situations through indicators. The criterion *Integrative* needs to be applied to a set of indicators. In this research, the indicators are evaluated individually and, therefore, it is difficult to choose a criterion that evaluates all them together. Finally, the criteria *Adaptable* is related to the ability of an indicator to adapt to other indicators, models or forecasting systems. Since in this research this aspect is not measured, this criterion was also discarded.

The ten resulting indicators are listed and defined in table 15 below. The indicators that were merged are more comprehensive than the previous, since they involve several criteria and therefore the definition is broader.

Table 15: Resulting list of criteria with definitions

Criteria	Definition
1. Reliable	The source of the indicator is contrasted and scientifically robust. The information provided by the indicator is trustworthy and objective
2. Practical	The indicator is easy to implement and to monitor. The method is well-defined scientifically
3. Understandable	The meaning of the indicator is clear and easy to understand. The indicator enhances the port performance communication
4. Suitable	The indicator is focussed and oriented towards the priorities and policies of the port
5. Cost effective	The implementation of the indicator is financially sound with regards to the expected result
6. Comparable	The indicator leads to potential performance comparisons between ports and allows to observe the trends over the years
7. Legislative priority	The indicator is regulated by well-recognized legislations / directives
8. Sensitive	The indicator is sensitive to the particularities of the system
9. Available	The indicator is available for both port stakeholders and general public
10. Broadly accepted	The indicator is included in more than 50% of the sources consulted

Once decided that these would be the initial criteria used to assess indicators, a first attempt to apply them into the category of environmental management indicators was done. By doing this, it was found out that in order to apply some of these criteria, a deeper research of the indicator was needed. This was the case of the criteria *Cost effective* and *Legislative priority*, which required further information on the indicator in order to be evaluated, in terms of costs and legislative issues, respectively. It was also found that other criteria, namely *Practical* and *Sensitive*, only were applicable to quantitative indicators. For these reasons, it was agreed that these four criteria would be applied lately in a second filter. It was also observed that the criteria *Suitable* and *Available* evaluate issues that depend on the port policies, which provide a different answer in each port. As a result, the first one was redefined into a more applicable criterion, called *Useful* and the second was discarded.

In this way, the previous ten criteria were divided into two groups in order to assess the indicators in two phases. The criteria provided in the first filter was considered to be more generic and applicable to all the indicators. In contrast, the second filter was considered to be more specific in which a previous research on the indicators' characteristics was needed and in which these criteria may not be applicable to all the indicators.

The first filter consisted of five criteria and although four of them maintained the same name from the table 15, they had a more comprehensive definition. The criterion *Suitable* was replaced for *Useful* and therefore also its definition. Table 16 below shows the resulting criteria to be applied in the first filter.

Table 16: List of criteria with definitions to be applied in the first filter

Criteria	Definition
1. Reliable	This criterion refers to whether it is possible to corroborate the information provided by the indicator independently from the port. In other words, through own ways and without asking for information at the port authority
2. Understandable	This criterion refers to whether the statement of the indicator is clear, easy to understand, and it neither raises doubts nor allows different interpretations
3. Useful	This criterion refers to whether the indicator is relevant and useful to assess the environmental management
4. Comparable	This criterion evaluates the comparability of indicator itself and over the time, regardless whether the information provided is reliable or not
5. Broadly accepted	This criterion determines if an indicator is recommended for more than half of the sources consulted

Once the criteria for the first filter were determined, the next step was to select the criteria that would constitute the second filter. As mentioned, the second filter comprised criteria that imply a deeper research on the characteristics of the indicators.

In the second filter, three criteria maintained the same nomenclature, namely the criteria *Cost effective, Legislative priority* and *Sensitive*. However, their definition was modified from the initial one provided in table 15, in order to facilitate their applicability in the assessment of the indicators. The criterion *Practical* was split into two criteria: *Clearly defined method* and *Easy to monitor*. This separation was done because in order to carry out a more detailed analysis these two concepts should be evaluated separately. Finally, it was considered necessary to have a criterion in the second filter that evaluate the importance of indicators, and for this reason a new criterion was proposed. This is the criterion *Significant*, which had not appeared before although it is related to the criterion *Relevant*, which appeared in the very initial list of criteria (see table 13). Table 17 lists the criteria selected for the second filter along with their updated definitions.

Table 17: List of criteria with definitions to be applied in the second filter

Criteria	Definition
1. Cost effective	The cost of the implementation of the indicator is financially sound with regards to the expected result. For qualitative indicators, it is considered the time invested to reply the indicator. For instance, indicators that may be quickly replied comply with the criteria, whereas management indicators that need more information, do not comply. For quantitative indicators it is considered the approximated cost of the cheapest method.
2. Legislative priority	The indicator is regulated by well-recognized national and international legislations / directives. If the indicator is not clear whether it is regulated or not, it is considered that this criterion does not apply to this indicator.
3. Sensitive	The indicator is sensitive to the particularities of the system. It changes at short term when there is an external change (there is a cause-effect relationship).
4. Clearly defined method	For qualitative indicators, the criterion applies to those indicators that a research on its method can be conducted. For the indicators that it is not possible to figure out how each port implements the indicator, it is considered that this indicator does not apply to this criterion.

	For quantitative indicators, the method is scientifically well-defined and it is based on well-established and well-known techniques.
5. Easy to monitor	There is a simple and practical procedure to measure the indicator. This procedure must contain few steps and must provide a value in a simple way. For qualitative indicators, it is considered that they are 'easy to monitor' if they provide a value (number) easily. Descriptions are not considered. Quantitative indicators are easy to monitor when they have an easy procedure.
6. Significant	For qualitative indicators, this criterion evaluates whether the indicator is relevant within its category of indicators. In order to determine which are the most significant, a comparison is carried out between all the indicators of the category. For quantitative indicators, it evaluates whether the indicator is relevant and if it makes sense to measure this indicator in a specific compartment (e.g. air, water, soil or sediment) of the port area. The relevance is determined by carrying out a research.

As it is observed in table 17, most of these criteria evaluate the indicators differently, depending if they are qualitative or quantitative indicators. In some of the cases, some of the criteria cannot be applied to all the indicators. Generally, qualitative indicators are from the categories of environmental management, resources consumption, waste production and port development. Contrarily, quantitative indicators mainly belong to the indicators' categories of air, water, soil and sediments emissions, noise and biodiversity. Nevertheless, there are some exceptions, and within the qualitative categories there may be some quantitative indicators, and vice versa.

This section has described the criteria that were applied in both filters to assess the indicators. In the following chapter, the methodology used to carry out this process is explained.

6.4 Filtering process of the indicators

This section details the methodology that was followed in order to filter the large number of indicators against the criteria selected and defined in the previous section. The filtering process consisted of three steps: i) the first filter, ii) a regrouping of the indicators and iii) the second filter of the indicators, as shown in figure 3 below:

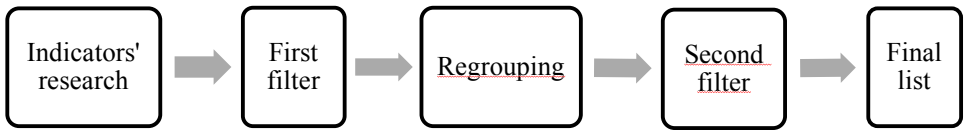

Figure 3: Filtering process of the indicators

These three steps are presented more in detail below:

First filter

The first filter consisted of analysing the complete broad list of indicators that were compiled. To do that, the criteria defined for the first filter were used. These criteria have been presented and defined in the previous table 16 and are the following: *Reliable, Understandable, Useful, Comparable*, and *Broadly accepted.*

The evaluation of the indicators against these five criteria was carried out by three researchers, with the objective of applying the filter in a contrasted way. Each evaluator, independently from the others, analysed the criteria met by each indicator. Table 18 shows an example of the assessment process of the first filter, dividing it in three main columns. The first column of this table contains the names of the indicators. The central column shows the assessments of the criteria for each indicator (this example corresponds to the results of the evaluator E2) and the third column summarizes the results of each evaluator (E1, E2 and E3).

If the indicator met a criterion, it was coloured with a green dot and if it did not comply, with a red dot. It was considered that an indicator was accepted by an evaluator when the result of the division between the accomplished criteria (green dot) and the total number of evaluated criteria was higher than 0.5. In other words, since in this first filter all the five criteria were applied, the indicators that met three or more criteria were accepted. A green tick (✓) indicates that the evaluator accepted this indicator, and a red cross (✗) that the indicator did not pass the first filter. All those indicators that were selected by at least two of the three evaluators were accepted. If there was only one green tick or any of them, then it was rejected.

Table 18: Example of the first filter assessment

Indicators	**Criteria (E2)**					**Evaluator**			**Is it Accepted?**
	1	2	3	4	5	**1**	**2**	**3**	
Total annual port waste sent to controlled landfill	🔴	🟢	🔴	🟢	🔴	✗	✗	✗	No
Total annual port waste stored in situ	🔴	🟢	🔴	🟢	🔴	✗	✗	✓	No
Existence of separate containers for the collection of port wastes	🟢	🟢	🟢	🟢	🟢	✓	✓	✓	Yes
Frequency of cleaning the port area	🔴	🟢	🟢	🟢	🔴	✓	✓	✗	Yes

As it is demonstrated in the example of table 18, the first two indicators were not accepted since the first one was not admitted by any reviewer and the second indicator was affirmed only by one (E3). The third and fourth indicators were both accepted since they were selected by, at least, two evaluators.

In this way, a first list of selected indicators was obtained. From the total number of 648 indicators, 354 were accepted through the first filter and 294 were rejected. The indicators that were rejected in this first filter are coloured in red in the compilation list of Annex II.

Regrouping the indicators

The indicators that passed the first filter were regrouped. In some cases, there were some indicators that were normalized against different references, and they were unified in one more generic indicator. This is the example provided below in table 19, where three indicators related to electricity consumption were expressed in different ways. Consequently, they were grouped into a generic indicator called ‘Total annual electricity consumption’. Nevertheless, it is important to mention that the information provided from the indicators that were regrouped (these three in the example below) was not lost; it was taken into consideration on the guidelines for the implementation of the indicator.

Table 19: Example of regrouping the indicators on 'annual electricity consumption'

Regrouped indicators	Resulting indicator
Total annual electricity consumption	Total annual electricity consumption
Electricity consumption per cargo handled	
Electricity consumption per number of employees	

In other cases, there were some indicators very similar, or that the response of one already implies the response of the other indicator. This is the case provided in the example of the table 20, which deals with the waste disposal methods. There is one indicator about the percentage of recycled waste, and another indicator on the percentage of all disposal methods. It is obvious that the result of the second indicator allows answering the first one. Therefore, they were grouped into one indicator as well.

Table 20: Example of regrouping the indicators on 'waste production'

Regrouped indicators	Resulting indicator
Percentage of disposal methods of port waste	Percentage of disposal methods of port waste
Percentage of recycled waste	

Annex II shows in orange the indicators that were sent to the regrouping process, 148 in total. Annex IV compiles these 148 indicators and regroups them, resulting in 39 accepted indicators. In other words, the regrouping process eliminated 109 indicators from the compilation list and reduced it from 354 (first filter) to 245 indicators (as it can be seen in figure 4 below).

Second filter

The second filtering process of indicators consisted of six criteria that evaluated individually the indicators that remained after the first and the regrouping process (245 indicators). As presented in table 17, the criteria for this second filter were *Cost effective, Legislative priority, Sensitive, Clearly defined method, Easy to monitor* and *Significant*. These criteria evaluated more specific issues of the indicators and, in many cases, it was necessary to conduct a previous research in order to determine if a particular indicator fulfilled a criterion.

In the same way as in the first filter, it was considered that an indicator was accepted when it met more than half of the criteria; in other words, the ratio between the accepted criteria and all the evaluated criteria had to be over 50%. In this second filter there was a major difference compared to the first one, because the total number of criteria evaluated was not always the same. Due to the different nature of the indicators, and considering that the criteria of the second filter are more specific, not always all criteria were applicable to all the indicators. It was also possible that, for certain indicators, not enough information was available to assess a specific criterion. In both cases, these criteria were not summed up in the total number of criteria assessed. An evaluation system was designed that took into account these particularities. This system is governed by the following formula:

$$\frac{Number\ of\ criteria\ fulfilled}{6-(Not\ applicable\ criteria+criteria\ with\ not\ enough\ information)} > 0{,}5 \quad \text{(Eq. 1)}$$

In the numerator, there is the number of criteria that are accomplished for a specific indicator. The number 6 in the denominator refers to the total number of existing criteria. From this value, it is deducted the number of criteria that are considered not applicable to this indicator and the number of criteria that do not provide enough available information for this indicator. In this way, the number of evaluated criteria is obtained. This value may vary between 1 and 6, and it be different for each indicator. The ratio should be greater than 0.5 in order to accept the indicator.

Table 21 shows a screenshot of the table used to evaluate the second filter. On the left there are the names of indicators to be assessed and on the right there is a table to evaluate the six criteria for each indicator. In the same way as in the evaluation of the first filter, a red dot indicates that the indicator does not meet the criteria and a green dot indicates that it does. In this second filter, as mentioned above, there are two more possibilities: i) a criterion may not apply to a particular indicator (grey dot), and ii) there is not enough information to assess a criterion for a specific indicator (blue dot).

Table 21: Example of the second filter assessment

Indicators	Criteria						Is it Accepted?
	1	2	3	4	5	6	
Biological Oxygen Demand (BOD)	🟢	🟢	🟢	🟢	🔴	🟢	✓
Annual amount of recovered rainwater	🔵	🟢	🟢	⚫	🟢	🔴	✓
Percentage of the port area that has a system for the collection and treatment of rainwater	🔵	🔴	🟢	⚫	🔴	🔴	✗

For example, as shown in the table, the indicator *Biological Oxygen Demand* fulfilled five of the six criteria and it was accepted because, by applying the equation (1), a ratio of 0.83 was obtained (which is higher than 0.5). The indicator *Total annual rainwater recovered* fulfilled three out of four criteria (for criterion 1 not enough information was found and criterion 4 did not apply to this indicator and, therefore, these two criteria were not counted). The ratio was 0.75, passing the second filter. Finally, the indicator *Percentage of the port area that has a system for the collection and treatment of rainwater* fulfilled just one of four criteria that were evaluated, by applying the formula a ratio of 0.25 was obtained and therefore it did not overcome the filter.

Due to the complexity of this method and the fact that it was necessary to find information for each indicator, this process was done by one researcher, instead of three as in the first filter. A total number of 72 indicators were rejected in this second filter, and they are coloured in yellow in the tables of Annex II. As a result, the initial number of 245 indicators was reduced to a list of 173.

The figure below summarizes the three main steps followed to filter the indicators and mentions the total number of indicators that resulted after the application of each filtering process.

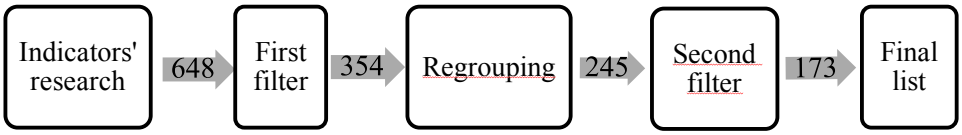

Figure 4: Number of indicators resulting after each filtering process

The final list of the 173 indicators is provided in Annex V. For each of these resulting indicators, a guideline or recommendation on how to implement this indicator was created. The structure of these guidelines and recommendations are presented in the section 6.7.

6.5 Classification of the filtered indicators

Based on the indicators that remained until the end in the filtering process, the final list of indicators that constitutes the TEIP tool was compiled (173 indicators). This list is was constituted from the remaining 134 'green' indicators from the compilation list of Annex II and the 39 indicators that resulted from the regrouping process in Annex IV. As mentioned previously, all these final 173 indicators are provided on the Annex V.

When the final list of indicators was analysed in order to develop the TEIP tool, it was found out that there were both quantitative and qualitative indicators. On one hand, the quantitative indicators were clearly identified as the output indicators of the tool (e.g. the number of environmental objectives defined). On the other hand, it was considered that qualitative indicators would be very helpful in two ways: i) to demonstrate existence or inexistence of a specific environmental topic (e.g. 'Has the port defined objectives for environmental improvement?') and ii) to identify issues that could be given as recommendations to the port authorities (e.g. 'Does the port have quantitative objectives?'). In addition, as a result of the suggestions provided by the TEIP reviewers (see chapter 7 of this deliverable for more information), two indicators were not included in the final list of TEIP indicators. According to this, the final 171 indicators were categorized in the following four groups, each one in a specific colour in the Annex V:

1. Quantitative indicators used as output indicators in the TEIP tool (green colour).
2. Qualitative indicators used as a question in the TEIP tool in order to demonstrate existence or inexistence of a specific environmental topic (yellow colour).
3. Qualitative indicators used as issues to take into account in the provision of recommendations to ports (blue colour).
4. Indicators rejected in the application of the TEIP tool (red colour).

These four possible options and the number of indicators that are derived to each option is schematized in figure 5 below:

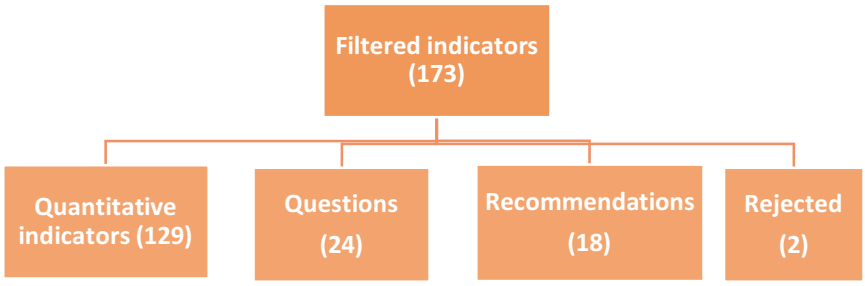

Figure 5: Classification of the filtered indicators

6.6 Interrelations aspects - indicators

The TEIP tool selects the indicators based on the significance of the aspects for the port. In other words, when an aspect is considered significant, its related indicators are suggested for monitoring.

It may be that the port already knows its significant aspects, or they may be obtained through the application of the TEAP tool (Puig et al, 2015). The following tables show the connections between each one of the 17 environmental aspects identified in TEAP and the related quantitative indicators (highlighted in green). There may be some questions (highlighted in yellow) on some aspects which, depending on the answer ('if yes' or 'if no'), further indicators and recommendations (highlighted in blue) are provided. This arrangement of the colours is based on the previous classification of indicators. When two dashes (--) are provided, it means that there is not any related indicator or recommendation. In brackets, next to each indicator, the 'indicator number' is mentioned. This is the reference number that each indicator has, as stated in each indicator guideline (See Annex VI).

Table 22: Indicators related with emissions of combustion gases

Aspect	**Emissions of combustion gases**	
Related indicators	- Carbon monoxide (CO) (G.1.1) - Nitrogen oxides (NO_x) (G.1.2) - Sulphur dioxide (SO_2) (G.1.3)	
Does the port measure or estimate its Carbon Footprint?	**If YES:**	- Total annual Carbon Footprint by scope (G.1.4) - Frequency of monitoring the Carbon Footprint in the port area (G.1.5) - Percentage of each energy source contributing to the Carbon Footprint (G.1.6) - Percentage of annual change in the Carbon Footprint (G.1.7)
	If NO:	- Carbon Footprint Recommendation (R.1.1)
Does the port differentiate dues for 'Greener' vessels?	**If YES:**	-- *(no related indicators)*
	If NO:	- Differentiate dues for 'Greener' vessels recommendation (R.1.2)

Table 23: Indicators related with emissions of other gases

Aspect	**Emissions of other gases**
Related indicators	- Ammonia (NH_3) (G.2.1) - Dioxins (G.2.2) - Heavy metals (G.2.3) - Ozone (G.2.4) - Volatile Organic Compounds (VOCs) (G.2.5) - Benzene (G.2.6) - Polychlorinated biphenyl (PCB) (G.2.7) - Frequency of photochemical smog events (G.2.8) - Persistent Organic Pollutants (POPs) (G.2.9)

	- Polycyclic Aromatic Hydrocarbons (PAHs) (G.2.10)

Table 24: Indicators related with emissions of particulate matter

Aspect	**Emissions of particulate matter**
Related indicators	- Dust (G.3.1) - PM10 (G.3.2) - PM2.5 (G.3.3)

Table 25: Indicators related with odour emissions

Aspect	**Odour emissions**
Related indicators	- Hydrogen sulphide (H_2S) (G.4.1) - Percentage of respondents that perceive odour (G.4.2)

Table 26: Indicators related with discharges of wastewaters

Aspect	**Discharges of wastewaters**
Related indicators	- Chlorophyll-a (G.5.1) - Biological Oxygen Demand (BOD) (G.5.2) - Chemical Oxygen Demand (COD) (G.5.3) - Algal Growth Potential (AGP) (G.5.4) - Dissolved Oxygen (DO) (G.5.5) - Inorganic ions (G.5.6) - Nutrients (in water) (G.5.7) - Nutrients (in sediments) (G.5.8) - Bacterial content (G.5.9) - Water pH (G.5.10) - Redox potential (in water) (G.5.11) - Redox potential (in sediments) (G.5.12) - Total hardness (G.5.13) - Total Organic Carbon (TOC) (in water) (G.5.14) - Total Organic Carbon (TOC) (in sediments) (G.5.15) - Total Oxygen Demand (TOD) (G.5.16) - Water colour (G.5.17) - Water temperature (G.5.18) - Plankton (G.5.19)

Table 27: Indicators related with discharges of hydrocarbons

Aspect	**Discharges of hydrocarbons**
Related indicators	- Oil Content (Hydrocarbons) (G.6.1) - Volatile Organic Compounds (VOCs) (in water) (G.6.2) - Volatile Organic Compounds (VOCs) (in sediments) (G.6.3)

Table 28: Indicators related with discharges of other chemicals

Aspect	**Discharges of other chemicals**
Related indicators	- Halogen content (G.7.1) - Conductivity (G.7.2) - Heavy metals (in water) (G.7.3) - Heavy metals (in sediments) (G.7.4) - Surfactants (G.7.5) - Tributyltin (TBT) (in water) (G.7.6) - Tributyltin (TBT) (in sediments) (G.7.7) - Persistent Organic Pollutants (POPs) (in sediments) (G.7.8) - Polychlorinated biphenyl (PCB) (in sediments) (G.7.9) - Polycyclic Aromatic Hydrocarbons (PAHs) (in sediments) (G.7.10)

Table 29: Indicators related with discharges of particulate matter

Aspect	**Discharges of particulate matter**
Related indicators	- Solid content in water (G.8.1) - Turbidity (water transparency) (G.8.2)

Table 30: Indicators related with emissions to soil and groundwater

Aspect	**Emissions to soil and groundwater**
Related indicators	- Electrical conductivity (G.9.1) - Soil pH (G.9.2) - Macronutrients (G.9.3) - Total Organic Carbon (TOC) (G.9.4) - Total port area with soil pollution (G.9.5) - Heavy metals (G.9.6) - Redox potential (G.9.7)

Table 31: Indicators related with water consumption

Aspect	**Water consumption**
Related indicators	- Total annual water consumption (G.10.1) - Annual amount of recovered rainwater (G.10.2) - Percentage of the annual variation in the water consumption (G.10.3) - Percentage of water recycled per total water consumption (G.10.4)

Table 32: Indicators related with electricity consumption

Aspect	**Electricity consumption**	
Related indicators	- Total annual electricity consumption (G.11.1)	
Is Onshore Power Supply (OPS) available at one or more of the berths?	**If YES:**	- Annual number of vessels connected to shore-side electricity (G.11.2)
	If NO:	- Provision of Onshore Power Supply recommendation (R.11.1)

Table 33: Indicators related with fuel consumption

Aspect	**Fuel consumption**	
Related indicators	- Total annual fuel consumption (G.12.1)	
Is Liquefied Natural Gas (LNG) bunkering available in the port today?	**If YES:**	--
	If NO:	- Provision of Liquefied Natural Gas (LNG) recommendation (R.12.1)

Table 34: Indicators related with generation of solid urban waste

Aspect	**Generation of recyclable garbage**	
Is the port monitoring the solid urban waste?	**If YES:**	- Amount of solid urban waste collected by type (G.13.1) - Amount of solid urban waste recycled by type (G.13.2)
	If NO:	- Solid urban waste monitoring recommendation (R.13.1)

Table 35: Indicators related with generation of hazardous waste

Aspect	**Generation of hazardous waste**	
Is the port monitoring the port hazardous waste?	**If YES:**	- Amount of port hazardous waste collected by type (G.14.1) - Amount of port hazardous waste recycled by type (G.14.2)
	If NO:	- Hazardous waste monitoring recommendation (R.14.1)

Table 36: Indicators related with generation of other waste

Aspect	**Generation of non-hazardous waste**	
Is the port monitoring the other waste?	**If YES:**	- Amount of port other waste collected by type (G.15.1) - Amount of port other waste recycled by type (G.15.2)
	If NO:	- Other waste monitoring recommendation (R.15.1)

Table 37: Indicators related with noise emissions

Aspect	**Noise emissions**			
Related indicators	- Noise levels in housing area around the port (G.16.1) - Percentage of survey respondents that perceive noise (G.16.2) - Number of noise claims from authorities (G.16.3)			
Does the port monitor noise?	**If YES:**	- Level of noise in terminal and industrial areas (G.16.4) - Maximum level of noise in terminals and industrial areas (G.16.5) - Frequency of noise measurements (G.16.6)		
		Does the port have a noise-zoning map?	**If YES:**	--
			If NO:	Noise-zoning map recommendation (R.16.1)
	If NO:	- Noise monitoring recommendation (R.16.2)		

Table 38: Indicators related with effects on biodiversity

Aspect	**Effects on biodiversity**	
Related indicators	- Percentage of algae coverage at particular port sites (G.17.1) - Percentage of large fish (G.17.2) - Heavy metals in fish samples (G.17.3) - Area of contaminated land returned to productive use (G.17.4)	
Is the port located in, or does it contain a designated protected area?	**If YES:**	- Total port area protected (G.17.5) - Number of bird species protected (G.17.6) - Number of flora species protected (G.17.7)
	If NO:	**--** *(no related recommendation)*

There are other categories of environmental indicators that only appear when specific aspects (from the previous list of 17) are significant. Although they are related to the aspects presented before, they are not present in TEAP. This is the case of meteorological data, sediments quality, energy consumption, other resources, and waste production indicators.

In the tables below, these categories of indicators are presented, along with the aspects that make them appear, named as 'related aspects' and coloured in grey colour. For instance, the category of indicators 'meteorological data' will be selected when any of the related aspects (emissions of combustion gases, other gases, particulate matter or odour emissions) is significant. In this case, the related question 'Does the port have a meteorological station?' is asked. Depending on the response ('if yes' or 'if no') further indicators or recommendations are provided.

Table 39: Indicators related with meteorological data

Indicators' category	**Meteorological data**	
Related aspects	- Emissions of combustion gases - Emissions of other gases - Emissions of particulate matter - Odour emissions	
Does the port have a meteorological station?	**If YES:**	- Meteorological data indicators (G.18.1)
	If NO:	- Meteorological station recommendation (R.18.1)

Table 40: Indicators related with sediments quality

Indicators' category	**Sediments quality**	
Related aspects	- Discharges of waste waters - Discharges of hydrocarbons - Discharges of other chemicals	
Does the port monitor sediments quality?	**If YES:**	- Sediments particle size distribution (G.19.1)
	If NO:	- Monitor sediments quality recommendation (R.19.1)

Table 41: Indicators related with energy consumption

Indicators' category	**Energy consumption**	
Related aspects	- Electricity consumption - Fuel consumption	
Does the port monitor the energy consumption?	**If YES:**	- Total annual energy consumption (G.20.1) - Percentage of the annual variation in the energy consumption (G.20.2) - Percentage of renewable energy per total energy consumed (G.20.3)
	If NO:	- Energy consumption monitoring recommendation (R.20.1)

Table 42: Indicators related with other resources

Indicators' category	**Other resources**	
Related aspects	- Water consumption - Electricity consumption - Fuel consumption	
Does the port monitor the annual paper consumption?	**If YES:**	- Total annual paper consumption (G.21.1)
	If NO:	- Annual paper consumption monitoring recommendation (R.21.1)

Table 43: Indicators related with waste production

Indicators' category	**Waste production**	
Related aspects	- Generation of recyclable garbage - Generation of hazardous waste - Generation of non-hazardous waste	
Is the port monitoring all the waste generated within the port area?	**If YES:**	- Total annual port waste collected (G.22.1) - Total annual port waste recycled (G.22.2) - Percentage of disposal methods of port waste (G.22.3) - Annual waste collected on port surface water (Anthropogenic debris) (G.22.4)
	If NO:	- Waste monitoring recommendation (R.22.1)
Does the port have separate containers for the collection of port wastes?	**If YES:**	--
	If NO:	- Existence of separate containers for the collection of port wastes recommendation (R.22.2)
Does the port have ship waste reception facilities?	**If YES:**	- Annual amount of ship waste collected by type of MARPOL annex (G.22.5)
	If NO:	- Existence of ship waste reception facilities recommendation (R.22.3)

Apart from the previous categories of indicators, there are also two types of environmental indicators that should be considered for monitoring and that are not directly related to SEAs. These categories are the environmental management and the

port development indicators. In this case, in order to introduce these categories in the TEIP tool, some questions are asked to the user, and depending on the responses, further indicators or recommendations are provided.

Table 44: Indicators related with environmental management (I)

Environmental management		
Has the port received any environmental complaint?	**If YES:**	- Total annual number of environmental complaints received (G.23.1) - Total annual number of environmental complaints resolved (G.23.2)
	If NO:	--
Does the port have a budget specifically for environmental protection?	**If YES:**	- Total annual budget allocated to environmental protection (G.23.3) - Percentage of the budged allocated to environmental protection out of the total budget (G.23.4) - Percentage of annual variation in the environmental budget (G.23.5)
	If NO:	- Environmental budged recommendation (R.23.1)
Does the Port have a certified Environmental Management System (EMS)?	**If YES:**	- Number of environmental objectives defined (G.23.6) - Percentage of environmental objectives achieved (G.23.7) - Number of environmental indicators monitored (G.23.8) - Number of Significant Environmental Aspects identified (G.23.9) - Percentage of employees working on environmental issues (G.23.10) - Frequency of environmental training sessions for port employees (G.23.11) - Percentage of port employees that received environmental training (G.23.12) - Annual number of training hours per employee (G.23.13) - Annual number of environmental reports published (G.23.14) - Annual number of press articles published concerning environment (G.23.15) - Annual number of conferences that the port authority has organised or participated in (G.23.16) - Number of environmental educational programmes or materials provided for the community (G.23.17) - Number of times that the Emergency Response Plan has been activated (G.23.18) - Total number and volume of (significant) oil and chemical spills (G.23.19) - Annual number of environmental accidents (G.23.20) - Annual number of environmental incidents (G.23.21) - Number of EMS audits completed versus planned (G.23.22) - Number of EMS audit findings (G.23.23) - Number of EMS audit nonconformities addressed versus found (G.23.24) - Number of fines received for non-compliance with environmental legislation (G.23.25)
	If YES:	- Number of times that the daily limit value of a certain environmental parameter has been exceeded (G.23.26)

	If NO:	- EMS recommendation (R.23.2)

In case that the respondent answered 'No' to the previous question on the existence of an EMS, the following questions are also asked:

Table 45: Indicators related with environmental management (II)

Does the port have an Environmental Policy?	**If YES:**	--		
	If NO:	- Environmental Policy recommendation (R.23.3)		
Has the port defined objectives for environmental improvement?	**If YES:**	- Number of environmental objectives defined (G.23.6) - Percentage of environmental objectives achieved (G.23.7)		
		Have management programmes and action plans been prepared to achieve each objective?	**If YES:**	--
			If NO:	Environmental management programme recommendation (R.23.4)
	If NO :	Environmental objectives recommendation (R.23.5) Environmental management programme recommendation (R.23.4)		
Has the port identified environmental indicators to monitor trends in environmental performance?	**If YES:**	Does the port have an environmental monitoring plan?	**If YES:**	- Number of environmental indicators monitored (G.23.8)
			If NO:	Number of environmental indicators monitored (G.23.8) Environmental monitoring plan recommendation (R.24.6)
	If NO:	Environmental monitoring plan recommendation (R.23.6)		
Does the port have an inventory of Significant Environmental Aspects?	**If YES:**	- Number of Significant Environmental Aspects identified (G.23.9)		
		Are there procedures to maintain and update the inventory of SEA?	**If YES:**	--
			If NO:	SEA inventory recommendation (R.23.7)
	If NO:	SEA inventory recommendation (R.23.7)		
Does the port have a representative responsible for managing environmental issues?	**If YES:**	- Percentage of employees working on environmental issues (G.23.10)		
	If NO:	Environmental manager recommendation (R.23.8)		
Does the port authority have an environmental training programme for its employees?	**If YES:**	- Frequency of environmental training sessions for port employees (G.23.11) - Percentage of port employees that received environmental training (G.23.12) - Annual number of training hours per employee (G.23.13)		
	If NO:	- Environmental training programme recommendation (R.23.9)		

Are there procedures to communicate environmental information internally and externally?	**If YES:**	- Annual number of environmental reports published (G.23.14) - Annual number of press articles published concerning environment (G.23.15) - Annual number of conferences that the port authority has organised or participated in (G.23.16) - Number of environmental educational programmes or materials provided for the community (G.23.17)		
	If NO:	- Environmental communication recommendation (R.23.10)		
Does the port have an Emergency Response Plan?	**If YES:**	- Number of times that the Emergency Response Plan has been activated (G.23.18) - Total number and volume of (significant) oil and chemical spills (G.23.19) - Annual number of environmental accidents (G.23.20) - Annual number of environmental incidents (G.23.21)		
	If NO:	- Emergency Response Plan recommendation (R.23.11)		
Has an external EMS audit been conducted?	**If YES:**	- Number of EMS audits completed versus planned (G.23.22) - Number of EMS audit findings (G.23.23) - Number of EMS audit nonconformities addressed versus found (G.23.24)		
	If NO:	- EMS audit recommendation (R.23.12)		
Does the port have an inventory of relevant environmental legislation and regulations related to its liabilities and responsibilities?	**If YES:**	Is the port in compliance with legislation legal limits?	**If YES:**	--
			If NO:	- Number of fines received for non-compliance with environmental legislation (G.23.25) - Number of times that the daily limit value of a certain environmental parameter has been exceeded (G.23.26)
	If NO:	- Environmental legislation inventory recommendation (R.23.13)		

Table 46: Indicators related with port development

Port development		
Is dredging carried out in your port?	**If YES:**	- Annual quantity or volume of dredged sediment (G.24.1) - Frequency of dredging (G.24.2) - Percentage of dredged sediment going to beneficial use (G.24.3) - Percentage of polluted dredging sediments (G.24.4)
	If NO:	--
Has the port authority carried out an Environmental Impact Assessment	**If YES:**	--
	If NO:	Development of an EIA recommendation (R.24.1)

(EIA) during the last 5 years?		

TEIP tool compiles all the indicators that are obtained directly from the aspects that are significant for the port, and the indicators and recommendations obtained as a result of the questions that have been asked to the user. These indicators are gathered internally by the tool and they are displayed and provided in the last step. In addition, a set of guidelines for the implementation of the indicators and with some recommendations are also provided. The following section shows the application of the tool, the several steps that compose it and the connections with TEAP tool.

6.7 Creation of the guidelines and recommendations

The main objectives of the TEIP tool are not only to provide ports with the list of indicators suggested for monitoring, but also to supply them with guidelines and recommendations for the proper implementation of these indicators. This section aims at presenting initially the structure of the guidelines and secondly of the recommendations.

The different nature of the indicators prevented to define a single structure of the guidelines for all the indicators. For this reason, two different structures were established. On one hand, a model was created for management and operational indicators, which are focussed on issues related to the elements of an Environmental Management System and on port operations. On the other hand, another template was designed for the environmental condition indicators, which measure physical and chemical parameters of the environment and, therefore, they require quantitative methods and measuring equipment. Next, the two templates of guidelines for indicators and the one for recommendations are displayed.

Structure of the guidelines for management and operational indicators

The template of the guidelines used for management and operational indicators is presented in table 47 below. These indicators belong mainly to the categories of environmental management, resource consumption, waste production, and port development. In addition, although most of the indicators on air emissions and effects on biodiversity are mainly condition indicators, some of them are management and operational indicators, such as Carbon Footprint and total port area protected indicator, which also follow this structure.

Table 47: Template of the guidelines for management and operational indicators

Indicator's name			
Category		**Indicator's code**	
Sub category			
Definition			
Importance			
Units of measurement			
Frequency			
Level of effort			

Notes	
References	

The first two elements of the template are the name of the indicator and its identification code, which is provided in order to have a specific reference of the indicator in each guideline. Then, the category and subcategory to which this indicator belongs is given, in order to place the indicator in context. After this, a definition of the indicator can be found and the reasons why this indicator is important are highlighted.

Then, three more technical elements of the indicator are detailed, which are the units of measurement, the frequency of monitoring (which defines how often the indicator should be monitored) and the level of effort involved to carry out this monitoring. This parameter may be obtained using the following legend:

Table 48: Level of efforts

Effort	Description
Low level	The information requested by the indicator is easily obtained.
Intermediate level	The information required by the indicator is not very complex, but it requires certain research to be obtained.
High level	The information required by the indicator is specific and it may require a deep research to be obtained.

Finally, the last two elements required in the structure for the management and operational indicators template are the notes (if needed) and the references used in that guideline.

Structure of the guidelines for condition indicators

The second template was developed considering the environmental condition indicators. These indicators require standardised methods and tools, such as laboratory instruments, probes, or complex equipment. The environmental condition indicators belong mainly to the categories of air emissions, water and sediments discharges and soil emissions. The template for this type of indicators is presented in table 49:

Table 49: Template of the guidelines for condition indicators

Indicator's name			
Category		**Indicator's code**	
Sub category			
Definition			
Importance			
Units of measurement			
Description of the methodology			
Detection limits			
Limit values			
Monitoring locations			
Frequency			

Approximate cost	
Level of effort	
Notes	
References	

The first elements that define the nature of the indicator are common to the previous template, from the indicator's name to the units of measurement. Some new elements are introduced: the description of the methodology used for the monitoring, the detection limits of the methodology, the limit values that are provided by the legislation (if any), the possible monitoring locations, and the approximate cost of the equipment needed to carry out the recommended method. Finally, there are four elements common to the template of the guidelines for management and operational indicators, which are the frequency of monitoring, the level of effort, the notes concerning any issue of this indicator and the references used for creating the guideline.

In Annex VI, some examples of guidelines are provided, including the two different templates

Structure of the recommendations

As mentioned, apart from the guidelines for the implementation of the indicators, the TEIP tool also provides the users with a set of recommendations for environmental improvement. The template of the environmental recommendations is provided below:

Table 50: Template of the environmental recommendations

Recommendation		**Recommendation code**	
Definition			
Contents			
Suggested indicators			
References			

This template consists of six main sections. Initially, the name and code of the recommendation are listed. Following it, the definition of the recommendation is provided. Then, there is the contents section, which refers to the information and the knowledge that this recommendation includes. The suggested indicators section contains the indicators from TEIP that are related to this recommendation. Finally the list of references used to create this recommendation is given.

Some examples of recommendations are included in the Annex VII of this thesis.

7 VALIDATION PROCEDURE AND FINAL TOOL

7.1 Validation procedure and feedback obtained

A comprehensive validation of the TEIP tool was carried out. The link was sent to a broad list of port professionals and stakeholders in order to obtain their feedback and opinion about the format and content of the tool. Among others, members of the ESPO Sustainable Development Committee and the ESPO Senior Advisor. In addition, an on-line webinar was undertaken, where the development of the tool was explained and a case study of a port was presented. Around 20 port-related professionals participated in the webinar. The feedback obtained from the reviewers was highly considered and much appreciated in order to improve the quality of the tool.

Below, the comments obtained from the reviewers and the actions taken are listed, categorised by the steps of the tool. When a suggestion was incorporated in the tool, the answer is coloured in green, when it was rejected, the answer is coloured in red, and when no action was needed, it is coloured in blue.

TEIP Introduction

- In the TEIP introduction, one user advised to include a link of TEAP to be able to identify the SEAs.
    - It was considered as a positive contribution, and a link to TEAP was provided in the introduction of the TEIP tool.

Step 2: Significant Environmental Aspects

- It was commented that, in the description of Step 2, it should be clearly mentioned that the aspects that have to be selected make reference to the whole port area, not only to the port authority.
    - It was agreed with the reviewer that this should be stated previously. In this step, the respondents have to select the aspects that are considered significant, and if it is not mentioned, it may create some confusions. In TEAP, it is already mentioned since the activities that are selected involve the whole port area. For this reason, the final sentence has been modified to: 'Please select the environmental aspects, from the following list, that are considered significant in your port (including the whole port area)'.
- It was also suggested to add the following text in the first paragraph of Step 2, to make clearer the functions of the tool to the user: 'Each environmental aspect is associated to several environmental indicators. When an aspect is selected, the related environmental indicators are activated'.
    - Following this suggestion, this sentence was added to the first paragraph of Step 2 of TEIP.

- It was suggested that the Step 2 of TEIP, which deals with the selection of Significant Environmental Aspects, should have the option for the respondent to introduce new aspects, in case that the port has other SEAs not mentioned in the available list.
    - It was agreed to include the opportunity to introduce new aspects under the category of 'other'. An empty space was provided to introduce additional environmental aspects.
- In the same step of TEIP, it was suggested to include the definition of the aspects to help the users, in line with the definitions provided in the TEAP tool.
    - It was agreed and the button *i* was added next to each aspect with its definition. In this way, the user can get a better insight of the aspect before selecting it.

Step 3: Questions on SEAs

- It was suggested that the question on *Meteorological data* 'Does the port have a meteorological station?' should be transformed to 'Does the port have access to meteorological data?' to avoid the situation where a port does have access to relevant data but does not own a station, and therefore would answer 'no'.
    - The reviewer was acknowledged for providing this suggestion. The research team agreed with this proposal and the question was modified.
- It was suggested to not include the paper consumption question in Step 3 and therefore to eliminate the related indicator. The reviewer commented that the consumption of paper is not a priority issue in a port authority and, for this reason; it was suggested to be deleted, since it is out of the scope of this sector.
    - Since this comment was obtained by a professional port auditor, it was agreed to not include this question and indicator. Initially, this question was introduced in Step 3 because there is not any environmental aspect related to the paper consumption.
- One respondent commented that the topic of ballast water does not appear on the TEIP tool.
    - It was replied that the issue of ballast water (together with bilge water or sewage) is part of the discharges to water and sediments (see page 86 of this thesis). For this reason, although the term 'ballast water' does not appear directly on the tool, it is already included on the aspects category 'Discharges to water/sediments'. To make it clearer and to avoid misunderstandings, shipping was included in the definition of the aspect *Discharges of wastewaters* as a possible source of emissions.

- One reviewer requested why the questions asked in Step 3 only concern to some SEAs and not to all of them.
    - It was explained to this reviewer that there are some SEAs that already have related indicators and therefore any question is needed. These indicators are kept internally and displayed at the last step. On the contrary, there are some aspects that need the answers to some questions in order to incorporate further indicators.
- It was mentioned that underwater noise is an issue that will be regulated in the future. For this reason, it was suggested that this topic could be added in the tool.
    - Noise is already included in the tool as an environmental aspect, and it has several indicators related to it. It was replied that underwater noise is too specific for being included in TEIP since this tool aims at providing a general overview of indicators for each specific port. However, it may be included or considered in a future version of the tool, if needed.

Step 4: Questions on management and development

- It was suggested that the budget question could be integrated within the EMS set of questions, when the user replies 'No' to the EMS certified.
    - It was rejected because the issues that are included in the set of questions related to the EMS are components of a management system. Although the existence of a budget for environmental protection is essential for the development of an EMS, it is not a requirement for its development.
- It was commented that several of the questions on monitoring and environmental impact assessment are already obligatory in some ports. The reviewer suggested to make a distinction between obligatory and voluntary environmental monitoring/actions.
    - This comment was acknowledged to the reviewer. However, it was not accepted, since in each country may be different in terms of regulations, it cannot be established which actions are compulsory and which are optional in a generic way. For this reason, this suggestion was not included.

Step 5: Environmental Performance Indicators

- It was suggested that the results of the tool, which are the indicators and recommendations, should be presented in bullet points in both, the Step 5 of the tool and in the output email, since the reviewer expressed his difficulties to read them.

- This comment was accepted because, in this way, a nicer format of the interface is given and it is more user-friendly.

- In addition, it was also commented that the results of the tool should be distinguished between the indicators and the recommendations.
    - Initially, the tool provided the indicators and the recommendations all together. The proposal of differentiating them was very welcomed and therefore it was carried out. A title was added before each group in order to introduce what was presented.

- It was also commented that it should be written in the interface that the user has to click on the hyperlink of the indicators and recommendations to have access to the guidelines that are provided.
    - It was agreed that this should be mentioned since otherwise the user could miss the information provided in the guideline or recommendations. For this reason, a sentence specifying this aspect was added previously to the final indicators as well as in the output email where a summary of the indicators and recommendations is provided.

- The three aspects *Generation of recyclable garbage*, *Generation of hazardous waste* and *Generation of non-hazardous waste* had a common recommendation on waste monitoring. It was suggested that each aspect should have its own recommendation, being more specific for each case.
    - This proposal was accepted and three specific recommendations were created, one for each category of waste generation. With this amendment, the user of the TEIP tool receives a specific recommendation for monitoring recyclable garbage, hazardous waste and non-hazardous waste.

- It was suggested that the indicator *Annual waste collected on surface water (Anthropogenic debris)* should contain the word 'port' in order to clarify that this refers to the anthropogenic debris collect within the area of the port.
    - It was accepted and the resulting indicator was re-called *Annual waste collected on port surface water (Anthropogenic debris)*. It was agreed that with this amendment, it is clear that the indicator is limited to the port area.

- In the same line as in the previous comment, it was suggested that the indicator *Total area protected* should include the word 'port' in order to make clear that it refers to the area limited by the port.
    - This proposal was also accepted and therefore this amendment was carried out. The final indicator was called *Total port area protected.*

- The recommendation *Existence of facilities for the treatment and cleaning of the dredged sediments* was suggested to be deleted since it is not compulsory for a port to have a treatment plant.
    - The research team agreed with the reviewer that it is not a relevant recommendation and therefore it does not have to appear as an output. Ports may have (or not) facilities for the treatment and cleaning of dredged sediments, but this existence will depend on the characteristics of the port. It is not a common recommendation that ports should have facilities aiming at that.
- It was suggested that the indicator *Percentage of employees participating in environmental issues* should modify the verb 'participating in' to 'working on' because the second one demonstrates a major active role of the port employees towards the environment.
    - This amendment was incorporated to the tool and the resulting indicator was written as the *Percentage of employees working on environmental issues*.
- It was suggested that the indicator *Number of port locations with soil pollution declared* should be re-written. It was mentioned that reporting the total port area that has soil pollution provides better information than the number of port locations with soil pollution.
    - As a result of this suggestion, this indicator was modified as *Total port area with soil pollution.*
- It was mentioned that in the indicator *Percentage of respondents that perceive noise* the word 'respondents' was not clear to whom it was referring to.
    - The concern of the reviewer was understood by the research team and therefore the indicator was modified as following: *Percentage of survey respondents that perceive noise*. This indicator is related to a potential survey on noise that the port may undertake.
- It was also commented that the indicator *Number of times that the daily limit value has been exceeded* was not very concise as to which parameter the indicator was referring to.
    - This comment also was taken into account and the name of the indicator was slightly amended. The final name of the indicator resulted as: *Number of times that the daily limit value of a certain environmental parameter has been exceeded.*
- Since the aspect *Generation of solid urban waste* was suggested to be modified to *Generation of recyclable garbage*, it was commented that the indicators related to this aspect also should be modified following this proposal.

- It was agreed that the indicators related to this aspect should be modified accordingly. Therefore the new indicators were *Amount of port recyclable garbage collected by type* and *Amount of port recyclable garbage recycled by type*.

- Since the aspect *Generation of other waste* was suggested to be modified to *Generation of non-hazardous waste*, it was commented that the indicators related to this aspect also should be modified following this proposal.
    - It was agreed that the indicators related to this aspect should be modified accordingly. Therefore the new indicators were *Amount of port non-hazardous waste collected by type* and *Amount of port non-hazardous waste recycled by type*.

- It was proposed that the list of resulting indicators should be presented in a more structured way in both the website and the email. It was suggested to present them in categories, in order to be better organised.
    - The research team recognised that the way that the indicators appear is not user friendly. Providing the indicators classified by categories at the last step of the tool would facilitate the understanding to the user.

- Due to the fact that the handling of bulk products may generate the release of particles into the air, the reviewer suggested that the indicators on *Meteorological data* should be activated for the ports that load and unload dry bulk. In particular, wind is a very important parameter to monitor to avoid the possible dispersion of particles into the air.
    - The concern of the reviewer was understood. However, this action would be related to the selection of activities, which is done in TEAP, not in TEIP. In addition, dry bulk is not the only activity that may generate particles, there are other activities that contributes to it, such as the fuel combustion. Moreover, meteorological data is also relevant for other aspects, namely, *Emissions of combustion gases*, *Emissions of other gases*, *Emissions of particulate matter*, and *Odour emissions*. For these reasons, this indicator is only activated in relation to these four aspects.

- The tool was reviewed by a noise specialist. This specialist proposed several noise indicators to be included in the tool.
    - The noise indicators provided by this reviewer were analysed and it was found that they were already included in the broad compilation of indicators (See Annex IX). Since these indicators did not pass either the first or the second filter, they were not included in the final list of indicators.

Email

- It was proposed that the guidelines of the indicators and recommendations could be attached to the email in a PDF format, instead of providing a hyperlink (as it is now).

    - The research team studied this proposal and agreed that it would be more user-friendly to have all the guidelines attached in the email. However, due to IT limitations, this proposal was not accepted. On one hand, it was seen that an email with a large amount of PDFs attached and with the unknown sender ('eports.cat') would be categorised as 'spam' and therefore the user would not receive it on its main inbox. On the other hand, to do so, a dynamic PDF generator was required since the responses from the users are different and therefore the guides attached vary each time. This would complicate the functioning of the tool and it was discarded.

Guidelines of the indicators and recommendations

- It was suggested that the template of the guidelines for the condition indicators (see section 5.5 of this thesis) should include a section containing the equivalences between the different units of measurement.

    - This proposal was accepted and, therefore, a new section, called 'Equivalence', was introduced to the indicators' guidelines that required it.

- There was also a suggestion for improving the structure of the recommendations, by introducing an example of a best practice. This was considered helpful to understand better the recommendations.

    - This proposal was also accepted. An example was added to each recommendation. In addition, the examples that are provided are from best practices of European ports, in order to make easier the application of the specific recommendation.

- One reviewer asked to include best practices for indicators, since it was already done for the TEIP 'recommendations'.

    - The proposal of providing a best practice (current example implemented in a port) for each indicator' guidelines is an interesting fact and it would definitely provide added value to the guidelines. However, realistically, for the matter of time and large amount of existing guidelines, it is not feasible to develop, at least in this stage of the tool.

- A reviewer mentioned that the inclusion of reference documents in the guidelines is interesting. He suggested that an added value could be to provide an online repository with these documents and hyperlinks.

    - This proposal would definitely reduce the amount of references that are included in the guidelines. The main inconvenience to delete and

incorporate them into an online repository is that the user does not have access to this repository when the guidelines are downloaded and printed out. Therefore, the references have to be included in the same guideline, and, for this reason, they cannot be transferred to an online repository.

- It was commented that the section on the 'level of effort' is useful, but may need to be elaborated a bit more. An example was proposed by the reviewer, for instance, in the indicator percentage of large fish, it is indicated that some effort is necessary, but not in a concrete way. In this case, the necessary amount of fish needed to come to sound results could be added.

    - It was accepted that the 'level of effort' section is very generic, providing only three possible options: low, intermediate or high effort. It is recognised that extra information specifically on each indicator may provide high benefit to the guidelines. Unfortunately, due to the time restrictions and the large number of guidelines, in the version of the tool that is presented in this thesis, it is not feasible to be amended.

General comments on TEIP

- Respondents that answered TEAP but not TEIP suggested that it would be interesting to provide a link of the TEIP tool on the email that is sent to the respondent when the TEAP tool is completed. This would give a second opportunity to the respondent to easily proceed to complete the indicators' tool, if he or she wishes that.

    - It was agreed that providing a link to the TEIP tool would be very interesting because, in this case, the user always may have direct access to the tool in the email provided by TEAP.

- It was asked if the tool will be validated by a panel of environmental managers/experts since it would give validity and consistence to the tool.

    - It was answered that the research team provided the link of the tool to several port environmental managers and stakeholders and that their feedback was received. With this feedback, some amendments were implemented in order to obtain a validated and updated tool.

- The same stakeholder asked whether the tool is designed to generate data in itself in order to analyse the results, such as the type of ports accessing the tool, number of hits per indicator/recommendation, among others.

    - It was replied that the research team have access to the results. However, there is not any program that analyses them. This analysis can be done manually if this information is required. In any case, the information is confidential.

- A question was raised concerning the connections between the TEIP tool with the PORTOPIA platform, whether system-to-system communication was established or it was in mind to be done.
    - It was said that at this moment, TEIP tool is placed at eports.cat website. In the future, a link of the eports.cat website may be introduced into the PORTOPIA platform.
- Another point was raised on the future management of the tool. It was asked if the idea is that ESPO after the PORTOPIA project take up these tools.
    - It was mentioned that both tools are linked as part of one methodology. One option for future management could be that this method could be part of ECOPORTS toolbox. However, this still needs to be discussed with ESPO.
- It was suggested to include social and economic indicators in the compilation of environmental indicators.
    - Although it was regarded as a very interesting proposal, it was considered that, for the time being, it was out of the scope of this research and tool. Including port social and economic indicators may well be taken into account in future research or further development of the tool.

7.2 TEIP final tool

This section shows the final interface of the tool, from the point of view of the user. Initially, the introduction presents the several steps that compose the TEIP tool. The time to complete the tool is estimated in 20 minutes, and the confidentiality is ensured.

The first page when entering to www.eports.cat/teip is the TEIP introduction. In figure 6 the different steps of the tool are briefly explained.

Figure 6: Final screenshot of the TEIP introduction

Step 1 requires the contact details of the respondent. It contains the name and country of the port, and the name, position and email of the respondent. A screenshot of this section is showed in figure 7.

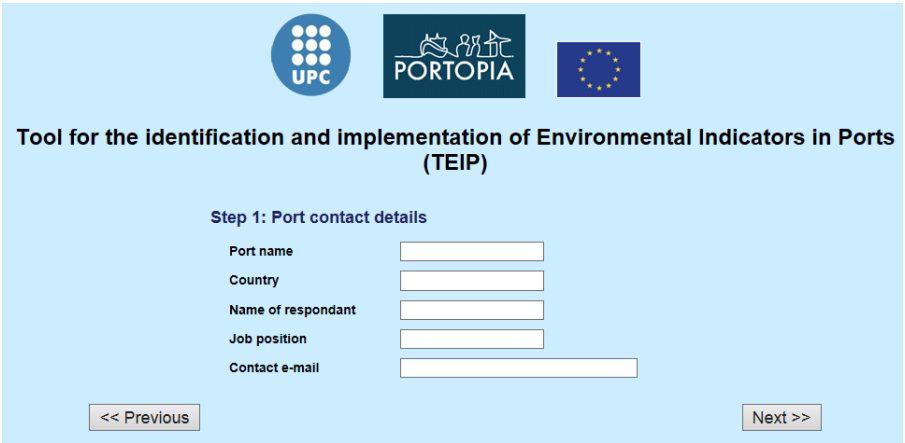

Figure 7: Final screenshot of TEIP Step 1: Port contact details

In the Step 2, the respondent has to select the aspects that are considered significant in his/her port. If the port has used the TEAP tool to identify significant aspects, then the user does not have to enter the SEAs, since they are already considered by the system. Figure 8 shows the interface of the step 2. The definition of each aspect is provided in the symbol *i* and there is a blank space to add further aspects, if it is the case.

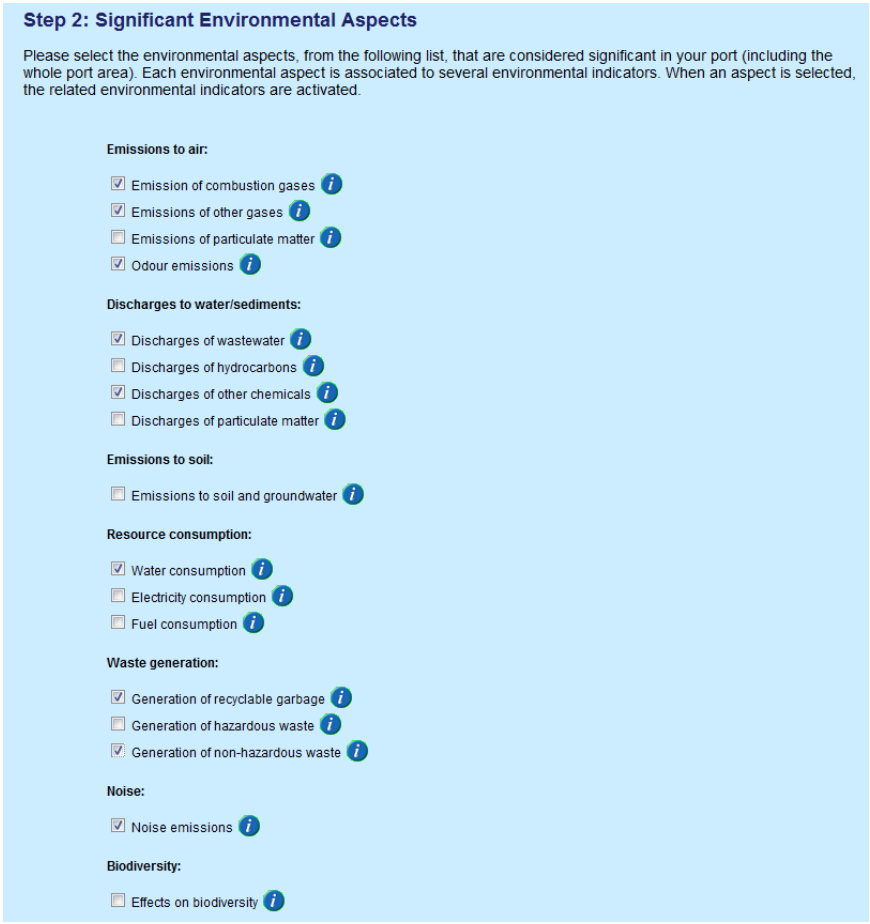

Figure 8: Final screenshot of TEIP Step 2: Significant Environmental Aspects

Step 3 is composed of a set of questions concerning some significant aspects that require more detail. For those aspects that the tool has enough information, it is not needed to answer further questions. As it can be seen in figure 9, the environmental aspect is mentioned and under it there is/are the related question(s). All the questions are Yes/No responses.

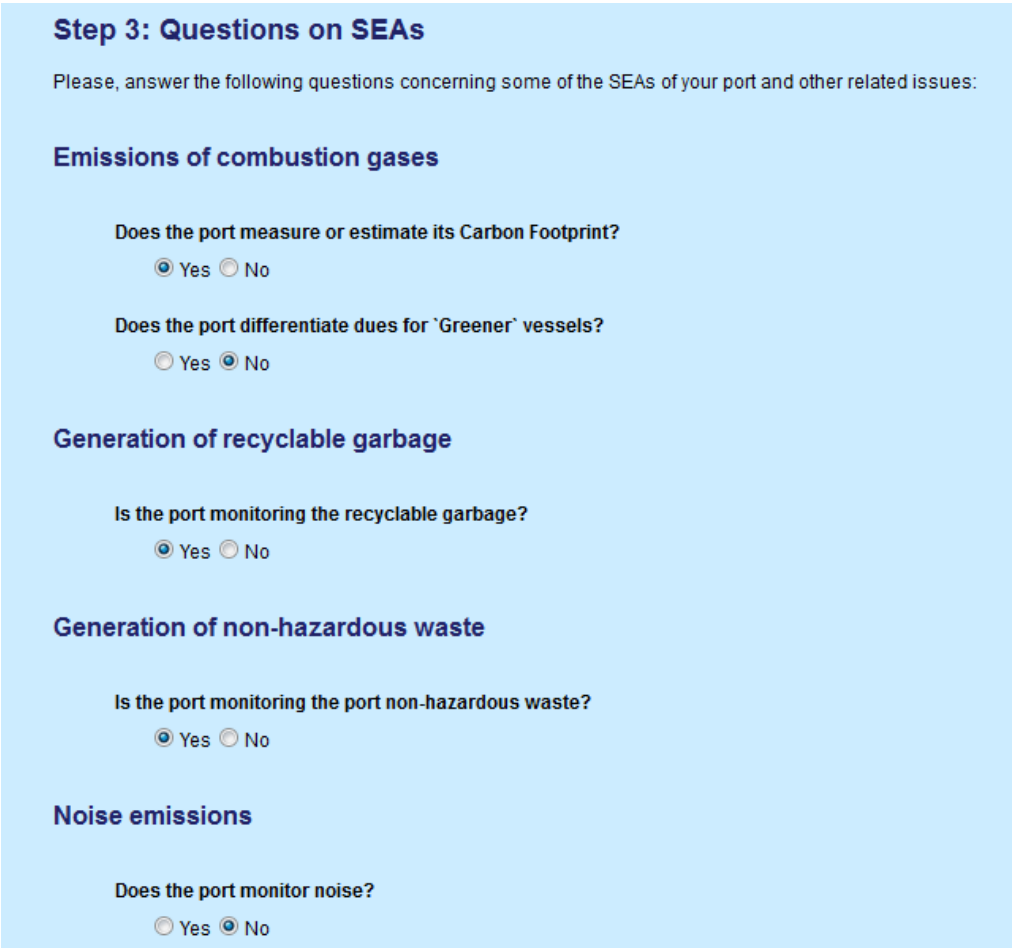

Figure 9: Final screenshot of TEIP Step 3: Questions on SEAs

The Step 4 comprehends a set of questions on environmental management and port development. It is asked in a separate step since they do not correspond to any SEA of the TEAP tool. All the questions are Yes/No responses. Depending on the answer, additional questions are displayed. For example, although it is not shown in figure 10, if the respondent selects 'No' in the first question of EMS, further questions on the EMS elements (e.g. environmental policy, objectives, monitoring plan) appear.

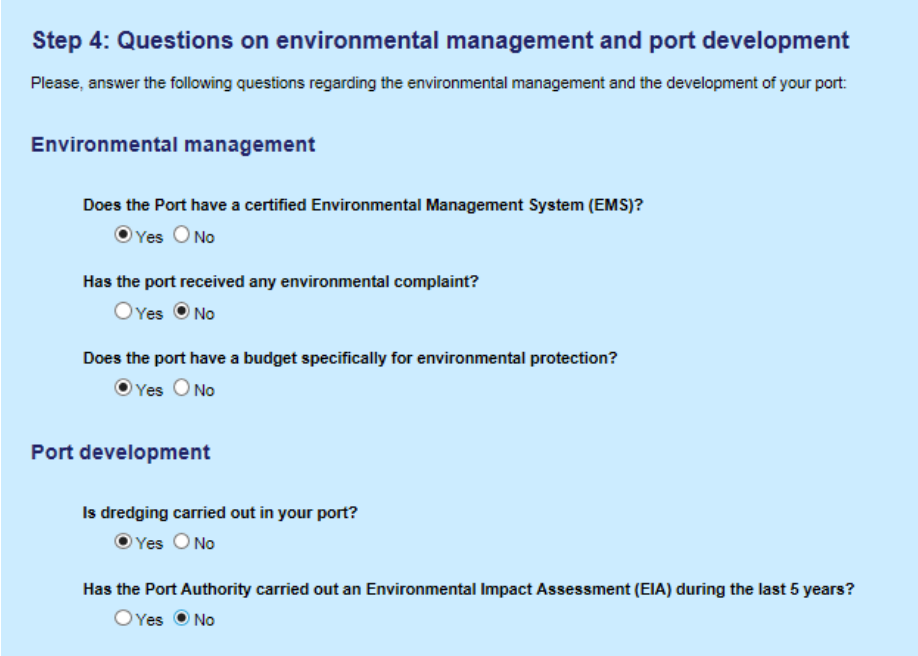

Figure 10: Final screenshot of TEIP Step 4: Questions on management and development

Finally, as shown in figure 11, the last step presents all the indicators that resulted recommended for monitoring in the port. The user can click over the indicators or recommendations in order to obtain their respective guidelines. The indicators are listed separately from the list of recommendations, and they are presented classified by categories of aspects.

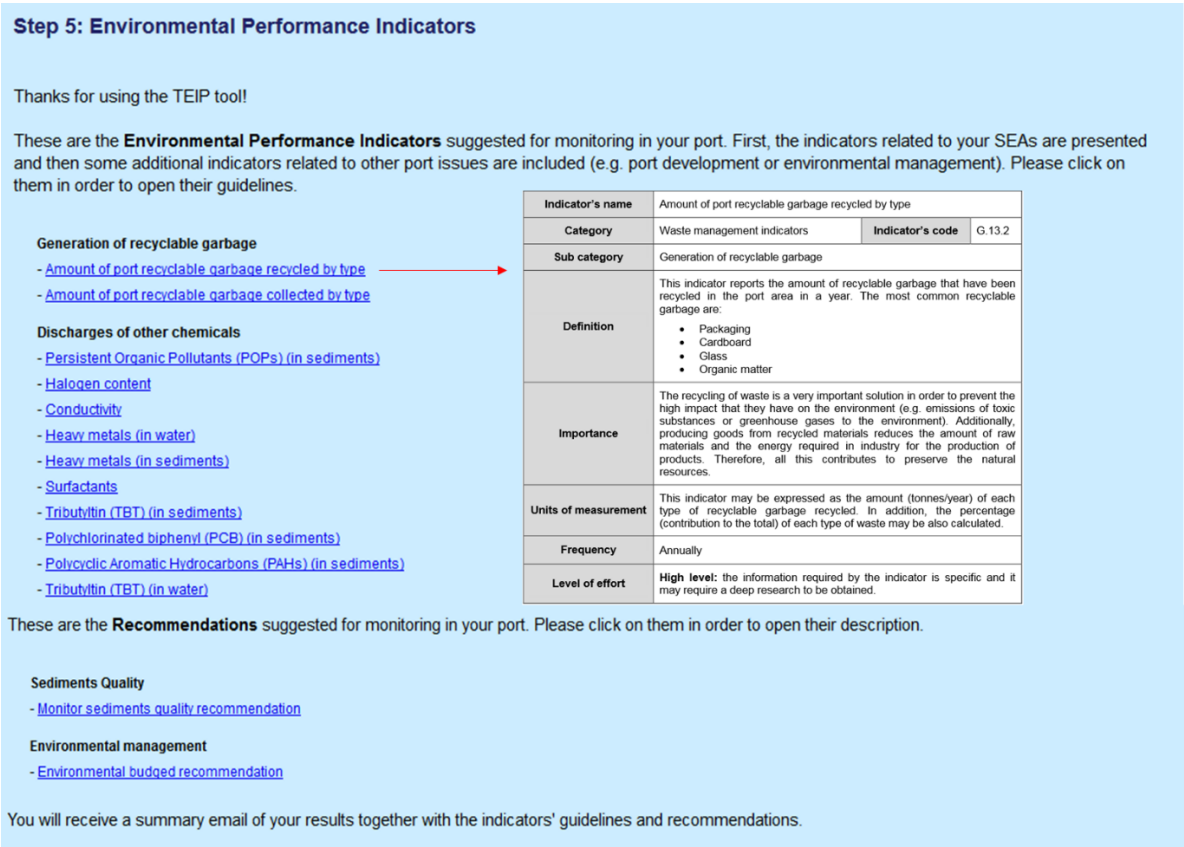

Figure 11: Selected final screenshot of TEIP Step 5: Environmental Performance Indicators

8 CONCLUSIONS

This report has demonstrated that Environmental Performance Indicators are a key element for ensuring environmental protection and sustainable development since they provide organisations with real and updated data and information of their environmental performance. The three major standards for the achievement of an Environmental Management System within the port sector, ISO 14001, EMAS and PERS, recognise the importance of using indicators and encourage organisations to establish a method to periodically evaluate the performance through indicators. Some examples of indicators are provided by these standards, for instance, EMAS provides a list of nine core indicators. However, they do not define any specific procedure.

Another interesting issue studied in this deliverable was the existing methods for the identification of indicators. The research demonstrated that there is a small number of procedures developed aiming at obtaining a system of indicators. The level of implementation of these methods among ports was studied, and it was found that they are not currently in place among the sector.

Based on the aforementioned reasons, it was detected that a new methodology, available to all European ports was needed, to be broadly implemented among ports, so that they are able to identify their most adequate indicators with a scientific procedure behind it. Through the existing techniques and on the considerations from the EMS standards, a new methodology was developed: the *Tool for the identification and implementation of Environmental Indicators in Ports (TEIP).*

To develop the tool, firstly an inventory of existing environmental indicators in ports was created. Research on the Global Reporting Initiative (GRI) guidelines, outcomes of research projects and studies, information from ESPO environmental reviews, pieces of legislation, port environmental reports, and EMS standards contributed to the identification of almost 650 indicators that are in use in ports. All the proposed indicators are real (existing), which proves that they are in place and take part in the daily environmental management. The broad variety of indicators also demonstrates the diversity of the sector in terms of needs, activities, responsibilities and priorities.

Since a large number of EPIs was compiled, it was required to reduce the extensive list of indicators to a shorter list, more appropriate to be implemented in ports. The filtering process consisted of three main steps: a first filter against a set of five criteria, a regrouping process, and a second filter against of six criteria. The criteria were established through a research of several different sources containing examples of criteria used. The indicators that complied with more criteria were selected and the ones that obtained a poor performance were rejected. After evaluating all the indicators, a total number of 171 indicators were selected to be incorporated into the TEIP tool.

This tool was developed using as a basis the aspects that were considered significant for the port. The interrelations between aspects and indicators were created. In TEIP, the list of significant aspects of the port may be obtained from two ways: as a result of applying the TEAP tool or by introducing the aspects manually. Some indicators are obtained straightaway when the aspect is selected as significant and other indicators are activated after answering a set of related questions. In any case, the user receives a set of indicators suggested for monitoring in the port, along with a guideline for its implementation. A set of recommendations are also provided. The tool suffered a process of validation from

sector stakeholders, which provided the opportunity to update and improve it. In addition, it will be presented to the next Sustainable Development Committee that will take place the 10th of October 2017 in Amsterdam, to get its final approval.

This method is applicable to all types of ports (e.g. seaport, inland port), no matter their country, geographical location, size or commercial profile since it provides specific results for each one. It is meant to be replied by the Port Authority, however, any port company can use it just selecting the activities carried out by this stakeholder.

This method assists port managers in identifying the EPIs of their own port area in a user-friendly, practicable and time-effective manner. This will help ports to have the suitable tools to measure their environmental performance, gather valuable elements for decision-making and to enhance their environmental performance in order to achieve a sustainable development. In addition, the adoption and application of TEIP have the potential to enhance further the exchange of knowledge and experience throughout the sector and with its wide range of stakeholders.

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ANNEX I: RESULTS OF THE INDICATORS' RESEARCH

The legend below shows the three possible options that were found in developing the reseach, coloured each one in a different colour:

	Legend
The list of aspects/indicators and the methodology is provided	
The list of aspects/indicators is provided	
Neither the list of aspects/indicators nor the methodology is provided	

The tables below contain the name, country and size of aech port that researched, the results on the indicators' research and the name of the document that contained this information.

1- European port authorities

Port of	Country	Size[1]	Indicators	Document
A Coruña	Spain	M	94	Env. Declaration 2012 / Memoria de sostenibilidad 2011
Vigo	Spain	S	66	Environmental Declaration 2010
Valencia	Spain	L	62	Memoria ambiental 2013
Roses	Spain	S	62	EMAS Environmental Declaration 2012
Bahía de Algeciras	Spain	L	43	Memoria Ambiental 2014
Cartagena	Spain	M	36	EMAS Environmental Declaration 2010 & 2011
Livorno	Italy	L	20	Dichiarazione ambientale 2012 -2015
Santander	Spain	M	102	Memoria annual 2013
Gijón	Spain	M	45	Memoria de Sostenibilidad 2013
Koper	Slovenia	M	23	Environmental Report 2012
Antwerp	Belgium	L	21	Sustainability report
Ceuta	Spain	S	15	Memoria de Sostenibilidad 2008
Belfast	UK	M	12	Environment Report 2013
Peterhead	UK	S	12	EMS 2011
Helsinki	Finland	M	9	Web-site / Annual report 2013
Alacant	Spain	S	9	Environmental best practices / Report Alacant port 2013
Felixstowe	UK	S	8	Environmental Report 2011-12
Ghent	Belgium	L	8	PERS: Environmental report 2013
Riga	Latvia	L	7	Environment Report 2012
Bremen / Bremerhaven	Germany	L	6	Environmental Report 2010
Cork	Ireland	M	11	Port of Cork. Environmental Report
Cagliari	Italy	L	51	Rapporto ambientale 2010
oerdijk	Netherlands	M	11	Port Environmental Review System (PERS) 2014
Dover	United Kingdom	M	7	Environmental Bulletin 2013
Piraeus	Greece	L	1	Annual financial report 2011
Tallinn	Estonia	L	0	-
Gothenburg	Sweden	L	30	Sustainability report
Barcelona	Spain	L	29	Annual report 2011
Hamburg	Germany	L	14	Sustainability report 2011/201

[1] Size: L (large) ports handle more than 25 annual million tonnes; M (medium) ports handle between 25 million tonnes and 5 million tonnes; and S (small) ports handle less than 5 million tonnes annually.

Stockholm	Sweden	M	12	Annual Report 2013
de Nantes St-Nazaire	France	L	11	Environmental report 2014
Odense	Denmark	M	8	Environmental report 2013-2014
Dublin	Ireland	L	7	Report 2013
Rotterdam	Netherlands	L	4	Annual Report 2009
Havre	France	L	3	Port website
Oslo	Norway	M	3	Port website
Genoa	Italy	L	1	Port website
Bruges-Zeebrugge	Belgium	L	1	Port website
Cyprus	Cyprus	M	0	-
Klaipeda	Lithuania	L	0	-
Setubal	Portugal	L	0	-
Patras	Greece	S	0	-
Malta	Malta	S	0	-
Civitavecchia	Italy	M	0	-
SeaPorts	Netherlands	L	0	-
Gdynia	Poland	M	0	-
Piombino	Italy	M	0	-
Amsterdam	Netherlands	L	0	-
Constanţa	Rumania	L	0	-
Kalundborg	Denmark	S	0	-
Split	Croatia	S	0	-

2. Non-European port authorities

Port of	Country	Size	Indicators	Document
Esperance	Australia	M	5	Annual marine sediment monitoring report 2014 Annual ambient air quality monitoring report 2014
Dakar	Senegal	M	4	Environmental and social management plan summary
Melbourne	Australia	L	7	Sustainably managing Factsheet September 2011. Safety and Environment Management Plan. October 2014
Sidney	Australia	L	7	Green Port Guidelines 2006 Ship Noise Monitoring Report 2015 Sustainability report 11/12.
Durban	South Africa	L	3	NPA Sustainability Report 2003
Montevideo	Uruguay	M	0	Comunicación proyecto nº7. Terminal granelera. Puerto de Montevideo. 2008.
Los Angeles	USA	L	19	Air quality report card 2009 Summary of Sediment Quality Conditions in the Port of Los Angeles 2010
Singapore	Singapore	L	15	Annual report 2014
Karachi	Pakistan	S	13	Website (www. http://kpt.gov.pk/)
Kuantan	Malaysia	M	11	Surface Water Contamination Due To Industrial Activities in Gebeng Area, Kuantan, Malaysia.
Abbot point	Australia	M	10	Cumulative assessment of the air emissions at the Abbot Point coal terminals. October 2012 Technical report marine water quality. August 2012

Santos	Brazil	L	10	Dados da coleta. Resultados analíticos
Manatee	USA	M	5	Port Manatee Master Plan 2009
Long Beach	USA	L	5	Air Quality Monitoring 2013 Annual report 2005
Buenos Aires	Argentina	M	5	Tercera conferencia hemisférica sobre gestión del medio ambiente portuario. 2012.
Shangai	China	L	5	Ship emissions inventory, social cost and eco-efficiency in Shanghai Yangshan port.
New York/ New Jersey	USA	L	4	A Clean Air Strategy For The Port of New York and New Jersey 2009
Cape Town	South Africa	M	4	Air Quality Specialist Report 2014.
Jacksonville	USA	M	3	Dames Point Marine Terminal Intermodal Container Transfer Facility (ICTF). Draft Environmental Assessment. 2012
Dubai	United Arab Emirates	L	3	Modeling Selected Water Quality Parameters at Jebel Ali Harbour, Dubai-UAE; Maraqa et al., 2007
Jeddah	Saudi Arabia	L	3	Determination of Heavy Metals in Four Common Fish, Water and Sediment Collected from Red Sea at Jeddah Isalmic Port Coast
Digna	Sudan	S	3	Environmental Impact Assessment (EIA) in Osman Digna (Suakin) Harbour. 2007
Hong Kong	Hong Kong	L	2	Website (www.mardep.gov.hk)
Port Klang	Malaysia	L	2	Distribution and Contamination of Heavy Metal in the Coastal Sediments of Port Klang, Selangor, Malaysia
Balboa	Panama	L	1	Studies of the Carbon Footprint for a Port in the Panama Canal
Chennai	India	S	1	Chenai port trust 2012
Papetee	French Polynesia	S	1	Coral and fish communities in a disturbed environment: Papetee harbor (Tahiti), 2000
Tangier	Morocco	L	1	Website (http://www.tmpa.ma)
Cartagena	Colombia	L	0	-
Cozumel	Mexico	S	0	-
Aguirre	Bolivia	S	0	-
Khor Fakkan/ Shargah	United Arab Emirates	L	0	-
Hilo	USA	S	0	-
Freeport	USA	S	0	-
Shenzhen	China	L	0	-
Da Nang	Vietnam	M	0	-
Tamjung Pelepas	Malaysia	L	0	-
Alexandria	Egypt	S	0	-
Malborought	New Zealand	S	0	-

3. Port Operators

Name	Country	Indicators	Document
Terminal de Contenidors de Barcelona (TCB)	Spain	19	Declaración Ambiental EMAS III 2011
Terminal de Contenedores de Gijón (TCG)	Spain	9	Declaración Ambiental EMAS III 2012
Terminal Carbón del Puerto de Ferrol	Spain	22	Environmental Declaration 2012

TEPSA. Terminal de Bilbao	Spain	13	Environmental Declaration 2011
SAGGAS (Planta de Regasificación de Sagunto, S.A.)	Spain	21	Declaración Ambiental 2011
Decal España S.A. Terminal de Barcelona	Spain	23	Environmental Declaration 2012
Cosco Group	China	34	Sustainability report 2013
Maersk Group	Netherlands	11	Sustainability report 2014
DP World	United Arab Emirates	2	Annual Report and Accounts 14
PSA International	Singapore	0	Annual report 2014
Gdynia Container Terminal	Poland	0	-
Barcelona Europe South Terminal	Spain	0	-
Europe Containers Terminal	Netherlands	0	-

4. Marinas

Name	Country	Indicators	Document
Club de Mar Mallorca	Spain	27	Declaración Ambiental 2011
Club Náutico Portosín	Spain	10	Declaración Ambiental 2012
Puerto Deportivo Bayona	Spain	28	Environmental declaration 2011
Marina Coruña	Spain	28	Declaración medioambiental 2012
Marina Port Vell Barcelona	Spain	11	Declaración ambiental 2013
Marina Port de Mallorca	Spain	13	Declaración ambiental Enero – Diciembre 2013
Puerto A Pobra do Caramiñal	Spain	22	Environmental Declaration 2006
Port ginesta	Spain	51	Declaració ambiental 2013
Marinas del Mediterráneo	Spain	0	-
Port Tarraco (marina)	Spain	0	-
Premier Marinas	United Kingdom	0	-
MDL Marinas	United Kingdom	0	-
Royal Ramsgate Marina	United Kingdom	0	-
Port Edgar Marina	United Kingdom	0	-
Port Ellen Marina	United Kingdom	0	-
Port Bannatyne Marina	United Kingdom	0	-
Port Dinorwic Marina	United Kingdom	0	-

ANNEX II: LIST OF INDICATORS COLLECTED AND THEIR SOURCES

The table below shows the sources of the indicators with their corresponding number, as they appear later in the tables of indicators.

Sources	Source number	Total number
PPRISM	1	311
ESPO Questionnaire	2	95
Global Reporting Initiative (GRI)	3	44
SDM	4	65
EPI ECOPORTS	5	56
Research studies	6	135
Legislation	7	115
Port environmental reports	8	282
Port organisations	9	61
EMS standards	10	98
INDAPORT	11	17

The indicators provided below include already the amendments provided by the TEIP reviewers. The total number of indicators identified is 648. They are distributed in the following way:

	Indicators rejected in the application of the first filter	294
	Indicators regrouped	148*
	Indicators rejected in the application of the second filter	72
	Resulting indicators	134

*This total amount of 148 indicators are regrouped into a list of 39 (Annex IV), which are added to the resulting indicators (134) to obtain a final list of 173 (see Annex V).

Environmental management

Environmental management indicators		Sources										
		1	2	3	4	5	6	7	8	9	10	11
Environmental Management System	Does the Port have a certified Environmental Management System (EMS)?	1							1			
	Number and type of EMS certifications	1				1	1	1	1			
	Year(s) of certification (number of years and year)	1				1						
	Is the port EMS re-certified?								1			
	Has the port completed the environmental review Self Diagnosis Method?	1										
	Have any customers requested the port to be EMS certified?	1										
	Is there a procedure to review the port's EMS program?				1							
	Number of tenants with an EMS								1			
	Number of suppliers with an EMS								1			

	Level of implementation of EMS in port facilities (% of third parties certified)									1		
Environmental Policy	Does the port have an Environmental Policy?	1			1				1			
	Is the policy signed by the Chief Executive / senior management?	1			1							
	Is the policy communicated to all relevant stakeholders?	1			1				1			
	Is the policy communicated to all employees?	1			1				1			
	Is the policy publicly available on the port's website?	1			1				1			
	Does the policy include reference to major objectives?	1			1							
	Does the policy include reference to publication of an Environmental Report?	1			1							
	Does the policy include reference to the identification and control of the port's Significant Environmental Aspects?	1			1							
	Does the policy include reference to introduction / maintenance of an Environmental Management System?	1			1							
	Does the policy aim to improve environmental standards beyond those required by legislation?	1			1							
	Does the policy include reference to reduction of resource consumption?				1							
	Does the policy refer to sustainable development?				1							
	Does the policy refer to Corporate Social Responsibility (social integration)?				1							
	Does the policy include reference to ESPO Code of Practice (2003)?	1										
Objectives and targets	Has the port defined objectives for environmental improvement?	1	1		1							
	Has the port defined targets for its objectives?	1			1							
	Have the objectives and targets been communicated?	1			1							
	Does the port have quantitative objectives?	1			1		1					
	Number of environmental objectives defined	1							1			
	Number of environmental objectives and targets achieved	1					1		1		1	
	Number of organisational units involved in achieving the objectives and targets						1				1	
	Percentage of environmental targets achieved	1							1			
	Percentage of environmental objectives achieved								1			
	Have management programmes and action plans been prepared to achieve each objective?	1										
Environmental	Does the port have an environmental monitoring plan?	1			1				1			

Monitoring Plan	Has the port identified environmental indicators to monitor trends in environmental performance?	1			1							
	Which environmental issues addresses the monitoring program?		1						1			
	Number of environmental indicators monitored	1							1			
	Frequency of monitoring each parameter	1				1						
	Number of monitoring locations for each parameter	1										
	Is the port environmental management monitored?				1							
	Description of the measures implemented by de port authority in order to put in place the monitoring program									1		
Significant Environmental Aspects	Does the port have an inventory of Significant Environmental Aspects?	1			1							
	Does the inventory consider aspects from the activities of tenants and operators?	1			1							
	Are there procedures to maintain and update the inventory of SEA?				1							
	Number of Significant Environmental Aspects identified	1							1			
Management organisation & personnel	Does the port have a representative responsible for managing environmental issues?	1			1							
	Are all personnel aware of the responsibilities and authority of this representative?	1										
	Does the representative report to senior management?				1							
	Does the representative coordinate environmental management throughout the port?				1							
	Does the representative ensure compliance with environmental policy?				1							
	Does the representative have responsibility for implementation/maintenance of an EMS?				1							
	Does the representative monitor current environmental issues and legislation?				1							
	Are the environmental responsibilities of this representative documented?	1			1							
	Are the environmental responsibilities of other key personnel documented?	1			1							
	Which methods are used to document the environmental responsibilities of other key personnel (e.g. job descriptions, written procedures)?				1							
	Number of levels of management with specific environmental responsibilities	1					1				1	
	Number of employees who have requirements of professional competence on environmental matters in their jobs	1					1		1			

	Number of employees who have obtained reward and recognition in comparison to the total number of employees who participated in the programme										1	
	Percentage of employees working on environmental issues										1	
	Number of environmental improvement suggestions from employees										1	
	Number of suppliers and contractors queried about environmental issues										1	
Environmental training and awareness	Does the port authority have an environmental training programme for its employees?	1			1							
	Existence of training (crane drivers, lift truck operators) with regard to noise						1					
	Is the environmental training fitted to employees' activities and responsibilities?	1			1							
	Have all the personnel whose work may create an impact on the environment received appropriate training?	1										
	Are environmental issues included in introduction programmes for new employees?	1			1							
	Has the port authority established procedures for identifying training needs?	1										
	Annual number of environmental training courses for port employees	1				1			1	1		
	Number of employees who have requirements of professional competence on environmental matters in their jobs	1					1				1	
	Number of port employees trained in environmental issues	1	1			1	1		1			
	Number of suppliers and contractors that require environmental training						1					
	Annual number of hours invested on environmental training for port employees	1					1		1			
	Frequency of environmental training sessions for port employees	1				1						
	Percentage of port employees that received environmental training	1					1		1	1	1	
	Number of trained people working with hazardous cargo	1										
	Are all employees aware of the importance of compliance with environmental policy?	1			1							
	Are all employees aware of the potential environmental impacts of their work activities?	1			1							
	Are all employees aware of their responsibility to conform to the environmental policy and management objectives?	1			1							
	Are all employees aware of the objectives, actions and programmes	1			1							

	carried out by the port in order to improve its environmental performance?											
	Annual number of training courses carried out / Annual number of training courses scheduled							1				
	Annual number of training hours per employee							1				
	Number of contracted individuals trained									1		
	Levels of knowledge obtained by training participants									1		
	Results of employee surveys on their knowledge of the organisation's environmental issues									1		
Environmental communication	Does the port publish a publicly available Environmental Report?	1	1		1	1	1					
	Does the port publish factual data by which the public can assess the trend of its environmental performance?	1										
	Are there procedures to communicate environmental information internally between the key environmental personnel?	1			1		1					
	Are there procedures to exchange port environmental information with stakeholders including external parties?	1			1		1					
	Which communications are used to communicate environmental information internally between the key environmental personnel?				1							
	Which communications are used to exchange port environmental information with stakeholders including external parties?				1							
	Are there procedures to consult with the Local Community on the port's environmental programme?	1			1		1					
	Frequency of meetings and consultations with external stakeholders	1					1		1			
	Number of internal meetings with key environmental personnel								1			
	Frequency of internal meetings with key environmental personnel	1										
	Annual number of environmental reports published	1				1				1		
	Annual number of press articles published concerning environment	1				1					1	
	Does the port website show environmental information?	1				1						
	Number of hours invested on environmental presentations given to stakeholders or interest groups	1	1			1	1					
	Annual number of conferences that the port authority has organized or participated in	1				1	1					
	Annual number of congresses and conferences attended by port employees concerning environment	1				1	1					

	Number of universities and research institutes co-operating with the port in the field of environment	1				1						
	Annual number of groups and students visiting the port for environmental education purposes	1					1					
	Number of environmental educational programmes or materials provided for the community										1	
	Favourable rating from community surveys										1	
	Port environmental impact score attributed by the local community								1			
	Port satisfaction survey: % of respondents that consider that the port is already taking serious measures for sustainability								1			
Emergency planning and response	Does the port have an Emergency Response Plan?	1			1	1			1	1		
	Does the port have an Emergency Response Plan specially designed for handling hazardous cargo?	1										
	Does the port have a Cargo Handling Plan to avoid accidents?	1										
	Does the port have an Oil Spill Response Plan?	1				1		1				
	Does the port have a Water Leakage Response Plan?		1		1							
	Number of response instructions defined for each emergency situation						1					
	Does the Emergency Response Plan include the potential environmental consequences and actions to be taken in the event of explosion, fire, floods, oil/chemical spill, and shipping accident (yes/no)?	1			1							
	Does the Emergency Response Plan specify the responsibility and role of each body: port authority, tenants and operators, ship agents, and external agencies?	1			1							
	Does the plan specify the communication, control and containment procedures?				1							
	Does the plan specify the location and type of equipment (on and off site)?				1							
	Does the plan specify the location and skills of trained personnel (on and off site)?				1							
	Does the plan specify the communication procedures with government departments, NGOs, local community, media and other interested parties?				1							
	Does the plan specify the responsibility for follow-up links?				1							
	Number of times that the Emergency Response Plan has been activated								1			
	Number of times that the Emergency Response Plan has been activated due to an on-land fire								1			

	Number of times that the Emergency Response Plan has been activated due to an off-shore fire							1			
	Amount of annual hazardous cargo handled	1						1			
	Total number and volume of (significant) oil and chemical spills	1	1	1		1		1	1			1
	Annual number of environmental accidents reported	1	1				1		1			
	Annual number of accidents at the port sea area								1			
	Annual number of bunkering-related pollution accidents	1				1		1				
	Annual number of vessel-related pollution accidents	1				1		1				
	Annual number of cargo-related pollution accidents	1				1		1				
	Annual number of environmental incidents reported		1					1	1		1	1
	Annual number of incidents with the need for intervention								1			
	Annual number of incidents with no need for intervention								1			
	Annual number of gas alarm incidents								1			
	Annual number of incidents related with the on land illegal dumping by third parties								1			
	Average response time in case of environmental accidents	1									1	
	Average response and correction time in case of environmental accidents	1					1					
	Maximum response time in case of environmental accidents	1										
	Frequency of safety equipment revisions	1										
	Does the port have a representative responsible for managing safety issues?	1										
	Are the responsibilities of this representative documented?	1										
	Are all the employees familiarised with safety regulations?	1										
	Has the port authority carried out an Environmental Risk Assessment during the last 5 years?	1					1					
	Number of Seveso II sites (sites containing large quantities of dangerous substances defined by the Directive 2003/105/EC)	1										
	Annual number of emergency drills	1									1	
	Annual number of emergency drills carried out / Annual number of emergency drills scheduled								1			
	Percentage of emergency preparedness and response drills demonstrating planned readiness										1	
	Number of hours of preventive maintenance to equipment per year										1	
	Has an external EMS audit been conducted?	1			1							

Environmental audit	Number of EMS audits conducted	1				1	1	1				
	Number of EMS audits completed versus planned										1	
	Number of nonconformities found in EMS audits	1	1									
	Number of nonconformities addressed	1										
	Time spent on addressing nonconformities	1										
	Number of identified environmental corrective actions that have been resolved or that are unresolved										1	
	Number of EMS audit findings										1	
	Frequency of review of operation procedures										1	
	Number of stakeholders audited								1			
Environmental legislation	Does the port have an inventory of relevant environmental legislation and regulations related to its liabilities and responsibilities?	1										
	Are there procedures to maintain and update the inventory of environmental legislation?	1										
	Are there methods to deal with non-compliance with internal and external standards?	1										
	Number of prosecutions received for non-compliance with environmental legislation	1										
	Number of fines received for non-compliance with environmental legislation	1					1	1			1	
	Monetary value of significant fines for non-compliance with environmental laws and regulations			1			1		1		1	
	Total number of non-monetary sanctions for non-compliance with environmental laws and regulations			1					1			
	Percentage of compliance with environmental legal requirements	1				1	1				1	
	Number of times that the daily limit value of a certain environmental parameter has been exceeded								1			
	Number of days in a year that the limit value is exceeded	1							1			
	Compliance with discharges of wastewaters legal limits		1						1			
	Compliance with discharges of oil legal limits		1									
	Compliance with discharges of other chemicals legal limits		1									
	Compliance with discharges of particulate matter legal values		1									
	Compliance with discharges of sediments legal limits		1									
	Compliance with limits at day, evening, and night time for noise level	1									1	
	Annual Number of environmental inspections	1							1			
	Total number of environmental licenses obtained	1										

	Total number of environmental licenses withdrawn or refused	1										
Environmental complaints	Total annual number of environmental complaints received	1	1						1	1		
	Annual number of environmental complaints received from NGOs	1										
	Annual number of environmental complaints received from people working in port area	1										
	Annual number of environmental complaints received from the Local Community	1										
	Annual number of environmental complaints received from port authority' employees	1										
	Annual number of dust-related complaints					1		1	1			
	Annual number of odour-related complaints		1									
	Annual number of noise-related complaints	1	1					1	1	1		
	Annual number of dredging-related complaints						1					
	Number of inquiries or comments about environmentally related matters										1	
	Total annual number of environmental complaints logged and investigated	1					1		1			
	Annual number of environmental complaints resolved where further action was necessary	1										
	Number of environmental complaints filed, addressed, and resolved through formal complaints mechanism			1								
	Annual number of environmental complaints resolved where no further action was necessary	1										
	Does the port have an environmental complaint registration system for following-up complaints from residents in the area?		1							1		
Environmental budget	Does the port have a budget specifically for environmental protection?	1										
	Total annual budget allocated to environmental protection	1	1	1					1			
	Amount of funding allocated to environmental training of employees	1			1							
	Amount of funding allocated to control environmental impacts	1			1							
	Amount of funding allocated to emergency response and prevention	1			1		1					
	Amount of funding allocated to environmental monitoring	1	1		1				1	1		
	Amount of funding allocated to stakeholder engagement and outreach activities	1			1							
	Amount of funding allocated to environmental reporting	1			1					1		
	Amount of funding allocated to biodiversity protection	1								1		

	Amount of funding allocated to waste collection and disposal								1			
	Amount of funding allocated to environmental liability insurance								1			
	Amount of funding allocated to external environmental management service								1			
	Amount of funding allocated to personnel engaged in comprehensive environmental management activities								1			
	Amount of funding allocated to the implementation and certification of an Environmental Management System								1			
	Amount of funding allocated to projects with environmental significance										1	
	Amount of funding allocated to support community environmental programmes										1	
	Amount of funding allocated to monitoring water quality										1	
	Amount of funding allocated to the treatment of contaminated soil	1				1		1			1	
	Investment costs of waste reception facility										1	
	Percentage of each environmental expense out of the total environmental budget								1			
	Percentage of the budget allocated to environmental protection out of the total budget	1							1			
	Percentage of annual variation in the environmental budget	1										
	Return on investment for environmental improvement projects										1	
	Savings achieved through reductions in resource usage, prevention of pollution or waste recycling										1	
	Environmental liabilities that may have a material impact on the financial status of the organisation										1	
Other Environmental management	Are copies of ESPO Environmental Review (2001) available in the port?	1										
	Are there procedures to involve all port users in the development of the environmental programme?	1										
	Are there initiatives to mitigate environmental impacts?			1					1			
	Number of significant environmental impacts of transporting products and other goods and materials for the organisation's operations, and transporting members of the workforce			1								
	Percentage of products sold and their packaging materials that are reclaimed			1								
	Significant negative environmental impacts in the supply chain			1								

	Percentage of new suppliers that were screened using environmental criteria			1								
	Number and description of initiatives implemented to prevent pollution	1					1				1	
	Number of solutions implemented to reduce pollution	1										
	Number of travel cards provided to port employees								1			
	Land use efficiency: percentage of the port area that is occupied by active installations								1		1	
	Number and frequency of specific environmental activities (e.g. audits)										1	
	Description of the conditions established for environmental-related aspects on the requirement form for port services under tender and concession companies									1		
	Longevity data for the population living around the port										1	
	Incidence of specific diseases, particularly among sensitive populations, from epidemiology studies in the port surroundings										1	
	Rate of population growth in the port surroundings										1	
	Population density in the port surroundings										1	
	Levels of lead in blood of the population living in the port surroundings										1	
	Measure of the condition of sensitive structures										1	
	Measure of the surface integrity of historical buildings in the port area										1	
	Involvement in Short Sea Shipping promotion										1	
	Total number of environmental management indicators: 238	132	21	10	62	24	32	12	65	13	48	2

Emissions to air

Emissions to air indicators		Sources										
		1	2	3	4	5	6	7	8	9	10	11
Emissions of combustion gases	Does the port measure or estimate its Carbon Footprint?	1										
	Does the port take measures to reduce its Carbon Footprint?	1										
	Total annual greenhouse gas (GHG) emissions	1		1			1	1	1	1	1	1
	Annual greenhouse gas (GHG) emissions from direct emissions (scope 1)	1		1					1			
	Annual greenhouse gas emissions (GHG) from energy indirect emissions (scope 2)	1		1					1			
	Annual greenhouse gas emissions (GHG) from other indirect emissions (scope 3)	1		1					1			

	Percentage of each scope contributing to the total emissions	1							1			
	Frequency of monitoring the Carbon Footprint in the port area					1						
	Percentage of each energy source contributing to the Carbon Footprint								1			
	Percentage of annual change in the Carbon Footprint	1							1			
	GHG emissions per TEU								1			
	GHG emissions per number of employees								1			
	Direct CO_2e emissions per number of employees								1			
	Indirect CO_2e emissions per number of employees								1			
	Kilometres driven by port vehicles	1	1			1		1				
	Number of vehicles in fleet with pollution-abatement technology										1	
	Number and description of initiatives implemented to reduce greenhouse gas emissions	1		1		1				1	1	
	Does the port differentiate dues for 'Greener' vessels?				1				1			
	Number of cargo movements by rail								1			
	Number of cargo movements by road								1			
	Ratio of truck to non-truck (rail, barge) cargo moves								1	1		
	Carbon monoxide (CO)	1				1	1	1	1	1	1	1
	Nitrogen oxides (NO_x)	1	1	1		1	1	1	1	1	1	1
	Sulphur dioxide (SO_2)	1	1	1		1	1	1	1	1	1	1
	Number of vessels participating in the Sulphur programme (aiming at reducing sulphur emissions)								1			
	Environmental benefits of the sulphur programme (emission reduction of SOx, NOx, PM, CO_2)								1			
	Description of the port activities that suppose the main sources of air emission									1		
	Schematic description of the operational teams available to the PA for monitoring air quality									1		
Emissions of other gases	Ammonia (NH_3)	1						1				
	Halogenated compounds	1					1	1				
	Dioxins							1				
	Hydrocarbons (HC)	1	1					1	1	1		
	Heavy metals	1						1	1	1		
	Photochemical oxidant (Ox)	1					1	1				
	Ozone						1	1	1	1		1
	Ozone depleting substances (CFCs)			1			1	1	1		1	
	Volatile Organic Compounds (VOCs)	1	1				1	1	1			1
	Benzene								1			
	Polychlorinated biphenyl (PCB)							1				
	Frequency of photochemical smog events							1				
	Persistent Organic Pollutants (POPs)	1						1				
	Other harmful air pollutants (HAP)	1						1				
	Polycyclic Aromatic Hydrocarbons (PAHs)							1	1			
Emissions of	Dust	1	1			1		1	1	1		
	PM10	1	1			1	1	1	1	1	1	1

particulate matter	PM2.5	1	1			1	1	1	1	1	1	
	Mineral fibre particulate							1				
	Dust monitoring related to coal handling operations		1						1			
Odour emissions	Acetaldehyde	1										
	Ammonia	1										
	Hydrogen sulphide (H_2S)	1							1			
	Methyl disulphide	1										
	Methyl mercaptan	1										
	Methyl sulphide	1										
	Styrene	1										
	Trimethylamine	1										
	Percentage of respondents that perceive odour								1			
Other emissions	Quantity of radiation released										1	
	Amount of heat, vibration, or light emitted										1	
Meteorological data	Temperature									1		
	Humidity									1		
	Surface wind pattern (direction, speed, intensity, frequency)						1			1		
	Rainfall						1					
	Atmospheric pressure						1					
	Solar Radiation						1					
	Cloudiness						1					
	Total number of air emissions indicators: 66	32	9	8	0	9	16	23	33	17	11	7

Discharges to water/sediments

Discharges to water/sediments indicators		Sources										
		1	2	3	4	5	6	7	8	9	10	11
Discharges of wastewaters	Percentage of reports with satisfactory results on water quality								1			
	Chlorophyll	1										
	Biological Oxygen Demand (BOD)	1	1				1	1	1			
	Chemical Oxygen Demand (COD)	1	1				1	1	1			
	Algal Growth Potential (AGP)	1					1	1	1			
	Dissolved Oxygen (DO)	1					1	1	1	1	1	
	Dissolved oxygen in surface waters								1			
	Dissolved oxygen in bottom waters								1			
	Number of ecological studies conducted in the port area	1										
	Inorganic ions	1						1	1			
	Sulphate						1					
	Total Phosphorus						1					
	Orthophosphates (dissolved inorganic phosphorus)						1					
	Total Nitrogen						1					
	Ammonium						1					
	Ammonia								1		1	
	Nitrite						1					
	Nitrate						1					
	Sulphide						1					
	Total coliform bacteria	1	1				1	1	1		1	
	Escherichia coli (E. coli)						1		1			
	Faecal coliforms						1		1			
	Faecal Streptococcus								1		1	
	Salmonella										1	

	Water pH	1	1				1	1	1		1		
	Redox potential	1						1	1				
	Total hardness						1						
	Total Organic Carbon (TOC)	1						1					
	Total Oxygen Demand (TOD)	1						1	1				
	Water colour	1					1	1	1				
	Water temperature	1	1				1	1	1	1	1		
	Zooplankton						1						
	Bacterioplankton						1						
	Phytoplankton						1	1	1				
	Description of the main sources of wastewater discharges in the port								1				
	Description of the main measures implemented by the port authority to control the discharges of wastewaters								1				
Discharges of hydrocarbons	Oil Content (Hydrocarbons)		1			1	1	1	1				
	Existence of water treatment system for oil spills					1							
Discharges of other chemicals	Organohalogenated substances							1					
	Halogen content	1						1					
	Complex organics	1						1	1				
	Conductivity	1	1				1	1	1				
	Water salinity	1	1				1	1	1		1		
	Specific simple organics	1						1					
	Heavy metals	1	1				1	1	1				
	Surfactants	1					1	1	1				
	Tributyltin (TBT)								1				
	Polycyclic Aromatic Hydrocarbons (PAHs)								1				
	Volatile Organic Compounds (VOCs)								1				
	Biocides								1				
	Other water pollutants	1											
	Inhibitory substances								1				
Discharges of particulate matter	Total Dissolved Solids (TDS)	1	1				1	1	1				
	Total Suspended Solids (TSS)	1	1				1	1	1		1		
	Settleable solids						1		1				
	Turbidity (water transparency)	1	1				1	1	1	1			
Sediments quality	Cyanogen compounds	1											
	Halogenated Hydrocarbon	1						1					
	Persistent Organic Pollutants (POPs)												
	Polychlorinated biphenyl (PCB)		1					1	1				
	Polycyclic Aromatic Hydrocarbons (PAHs)	1	1					1	1				
	Tributyltin (TBT)		1					1	1				
	Redox potential								1				
	Total Organic Carbon (TOC)						1		1				
	Organic Carbon						1		1				
	Amount of organic matter	1							1				
	Volatile Organic Compounds (VOCs)								1				
	Biocides								1				
	Total phosphorus						1		1				
	Orthophosphates (dissolved inorganic phosphorus)						1						
	Total Nitrogen						1						
	Nitrite						1						
	Nitrate						1						
	Kjeldahl nitrogen						1		1				

	Ammonium						1					
	Calcium						1					
	Nutrients	1	1					1	1			
	Sulphide (acid volatile sulphides)						1					
	Heavy metals	1	1				1	1	1			
	Sediments particle size distribution	1							1			
	Benthal oxygen demand						1					
	Number of FEPA (Food and Environmental Protection Act) sediments analysis		1									
	Percentage of reports with satisfactory results on sediment quality	1						1				
	Total number of discharges to water and sediment indicators: 83	33	18	0	0	3	44	33	51	3	9	0

Emissions to soil

Emissions to soil indicators		Sources										
		1	2	3	4	5	6	7	8	9	10	11
Emissions to soil and groundwater	Electrical conductivity	1					1					
	Soil pH	1					1	1				
	Organic contaminants	1						1				
	Macronutrients	1						1				
	Water Content	1										
	Soil porosity	1										
	Bulk density	1										
	Soil Organic Matter	1					1					
	Total Organic Carbon (TOC)	1						1				
	Particulate organic matter	1										
	Soil occupation efficiency	1							1	1		1
	Total port area with soil pollution						1		1			
	Heavy metals	1	1				1	1				
	Land area rehabilitated in the port area										1	
	Redox potential						1					
	Hydrocarbons						1					
	Availability of a soil pollution map	1				1		1				
	Total number of emissions to soil indicators: 17	13	1	0	0	1	7	6	2	1	1	1

Resource consumption

Resource consumption indicators		Sources										
		1	2	3	4	5	6	7	8	9	10	11
Energy consumption	Total annual energy consumption								1		1	1
	Total annual energy consumption by energy source	1					1	1	1		1	
	Percentage of each energy source	1					1					
	Energy consumption within the port authority			1								
	Energy consumption outside the port authority			1								
	Percentage of energy consumption by use								1			
	Energy consumption per cargo handled								1		1	
	Energy consumption per number of employees								1			

	Energy intensity			1								
	Direct energy consumption by primary energy source			1				1				
	Indirect energy consumption by primary energy source			1				1				
	Percentage of the annual variation in the energy consumption			1				1				
	Variation in the energy requirements of products and services			1								
	Energy saved due to conservation and efficiency improvements			1			1				1	
	Initiatives to provide renewable energy-based products and services			1				1				
	Number of energy-efficiency initiatives implemented	1										
	Initiatives to reduce indirect energy consumption and reductions achieved			1								
	Does the port have a programme to increase energy efficiency?	1										
	Does the port produce any form of renewable energy?	1						1				
	Total annual renewable energy generated							1				
	Total annual renewable energy consumed	1					1		1			
	Percentage of renewable energy per total energy consumed	1						1	1	1		
	Installed capacity of renewable energy							1				
	Installed capacity cogeneration							1				
	Annual energy use for port lighting									1		
Water consumption	Total annual water consumption	1	1				1	1	1	1		1
	Total annual water withdrawal by source			1			1	1	1			
	Percentage of water withdrawal by source								1			
	Total annual water consumption by use								1			
	Percentage of water consumption by use								1			
	Total annual water consumption per cargo handled								1			
	Total annual water consumption per number of employees								1			
	Daily average water consumption for cleaning de port area								1			
	Water sources significantly affected by withdrawal of water			1			1					
	Volume of unnacounted (lost) water								1			
	Water consumption from port's sources per number of employees								1			
	Annual rainwater used for cleaning de port area								1			
	Annual amount of recovered rainwater								1			
	Percentage of the port area that has a system for the collection and treatment of rainwater								1			
	Percentage of the annual variation in the water consumption								1			

	Total annual non-drinking water consumption							1				
	Total annual drinking water consumption		1					1				
	Cost per unit of water consumed		1				1					
	Total annual water recycled and reused	1						1				
	Percentage of water recycled per total water consumption	1		1								
	Total annual water consumption / square meters of the port service area			1				1	1			
	Annual number of water leakages		1									
	Percentage of showers and toilets with a water-saving system							1				
	Efficiency of the water distribution network: percentage for those Port Authorities that undertake the direct management of such distribution network								1			
	Change in groundwater level									1		
Electricity consumption	Total annual electricity consumption	1	1				1	1	1		1	
	Average daily electricity consumption in port buildings							1				
	Electricity consumption per cargo handled							1				
	Electricity consumption per number of employees							1				
	Percentage of electricity consumption by use							1				
	Cost per unit of electricity consumed		1									
	Amount of electricity saved due to energy-efficiency improvements	1										
	Is Onshore Power Supply (OPS) available at one or more of the berths?	1			1							
	Annual number of vessels connected to shore-side electricity	1	1					1				
	Percentage of vessels calling at the port that connect to shore-side electricity							1				
	Amount of electricity provided to vessels (shore-side electricity)							1				
	Environmental benefits of shore-side electricity (emission reduction of SOx, NOx, PM, CO_2)							1				
	Percentage of low consumption lights compared to total number of lights	1	1									
	Total annual electrical energy consumption per square meters of the port service area								1			
Fuel consumption	Total annual fuel consumption by type	1	1					1				
	Percentage of fuel consumption by type							1				
	Percentage of fuel consumption by use							1				
	Annual fuel consumption per number of employees							1				

	Annual fuel consumption per travelled kilometre							1				
	Annual fuel consumption per cargo handled								1			
	Annual fuel consumption per square meters of the service area								1	1		
	Total annual gas consumption (NG, propane, ...)								1			
	Total annual petrol consumption								1			
	Total annual gas oil consumption								1			
	Total annual fuel provided to port authority vessels								1			
	Total annual fuel provided to port authority vehicles								1		1	
	Annual natural gas consumption in port buildings								1			
	Average daily natural gas consumption in port buildings								1			
	Cost per unit of fuel consumption		1									
	Monthly Diesel oil consumption		1					1	1			
	Amount of fuel saved due to energy-efficiency improvements	1										
	Is Liquefied Natural Gas (LNG) bunkering available in the port today?				1				1			
Other Resources	Total annual paper consumption								1			
	Paper consumption per number of employees								1			
	Rechargeable batteries consumption / number total of batteries								1			
	Total annual consumption of lubricants								1			
	Total annual consumption of ink cartridges								1			
	Total annual consumption of tonners								1			
	Total annual consumption of batteries per number of employees								1			
	Material efficiency: Annual mass-flow of different materials used (excluding energy carriers and water)										1	
	Amount of hazardous materials used by contracted service providers										1	
	Amount of cleaning agents used by contracted service providers										1	
	Amount of recyclable and reusable materials used by contracted service providers										1	
	Total number of resource consumption indicators: 93	17	11	14	0	0	8	7	64	7	13	3

Waste production

Waste production indicators		Source										
		1	2	3	4	5	6	7	8	9	10	11
Generation of waste	Amount of materials used by weight or volume			1			1		1			

Surface percentage of the port service area provided with waste water collection and treatment			1			1	1		1		
Total annual port waste collected	1	1	1		1	1	1	1		1	
Total annual port waste generated								1		1	
Total annual port waste recycled								1		1	
Percentage of disposal methods of port waste	1	1				1	1				
Percentage of recycled waste						1		1			
Total annual port waste sent to incineration								1			
Total annual port waste sent to controlled landfill						1		1		1	
Total annual port waste stored in situ						1					
Existence of separate containers for the collection of port wastes	1		1		1	1					
Frequency of cleaning the port area	1				1		1				
Percentage of waste handled per total cargo handled	1	1					1	1			
Number of operations with high level of waste (>0,19% of total cargo handling)	1	1					1				
Number of port stakeholders with a Waste Management Plan	1				1		1	1			
Existence of waste processing facilities					1						
Existence of ship waste reception facilities	1						1	1			
Total annual amount of ship waste collected	1						1	1			
Number and description of initiatives implemented to reduce, recycle or reuse waste	1				1		1				
Number and description of initiatives implemented to improve port waste management								1			
Percentage of recovered waste						1		1	1		
Percentage of annual variation in the port waste generation		1									
Annual cost of waste treatment	1						1				
Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel convention Annex I, II, III and VIII, and percentage of transported waste shipped internationally			1				1				
Annual waste collected on port surface water (Anthropogenic debris)	1				1		1	1	1		
Annual total amount of ship waste collected in ship waste reception facilities (Annexes of MARPOL convention)	1										
Number of vessels that provided MARPOL ship waste								1			
Amount or type of wastes generated by contracted service providers										1	
Description of the main activities or sources of waste generation within the port								1	1		
Total annual wastewater treated in the waste water treatment plant								1			

	Total annual wastewater discharges by quality and destination			1					1	1		
	Amount of effluent water from treatment of sludge		1									
	Existence of a wastewater treatment plant	1				1		1				
	Percentage of the port area that has a system for the collection and treatment of wastewaters								1			
Generation of recyclable garbage	Existence of separate containers for the collection of port recyclable garbage	1										
	Annual amount of port recyclable garbage collected by type	1					1		1			1
	Percentage of each type of port recyclable garbage collected		1						1			
	Annual amount of port recyclable garbage recycled by type	1	1				1		1	1		
	Percentage of each type of port recyclable garbage recycled								1			
	Number and description of initiatives implemented to reduce, recycle or reuse port recyclable garbage	1				1				1		
	Time spent on litter collection		1									
Generation of hazardous waste	Existence of separate containers for the collection of port hazardous waste	1										
	Annual amount of port hazardous waste collected by type	1					1	1	1	1	1	1
	Percentage of each type of port hazardous waste collected		1						1			
	Annual amount of port hazardous waste collected per number of employees								1			
	Annual amount of port hazardous waste collected per cargo handled								1			
	Annual amount of port hazardous waste reduced by pollution prevention initiatives	1										
	Annual amount of port hazardous waste eliminated by changes in materials						1					
	Annual amount of port hazardous waste recycled by type	1	1				1		1	1		
	Percentage of each type of port hazardous waste recycled		1						1			
	Annual amount of oil collected and recycled	1	1					1	1			
	Annual amount of ship waste MARPOL annex I (oil) collected	1	1					1	1			
	Annual amount of ship waste MARPOL annex II (noxious liquid substances carried in bulk) collected	1	1					1	1			
	Annual amount of ship waste MARPOL annex III (harmful substances) collected	1						1				
	Existence of an oil spillage treatment plant	1										
Generation of non-hazardous waste	Existence of separate containers for the collection of port non-hazardous waste	1										
	Annual amount of port non-hazardous waste collected by type	1					1		1			

	Percentage of each type of port non-hazardous waste collected	1	1									
	Annual amount of port non-hazardous waste recycled by type	1	1				1		1	1		
	Percentage of each type of port non-hazardous waste recycled	1	1									
	Amount of port non-hazardous waste collected per cargo handled								1			
	Amount of port non-hazardous waste collected per number of employees								1			
	Annual amount of port non-hazardous waste reduced by pollution prevention initiatives	1										
	Annual amount of ship waste MARPOL annex IV (sewage) collected	1	1					1	1			
	Annual amount of ship waste MARPOL annex V (garbage) collected	1							1			
	Total number of waste production indicators: 65	34	17	6	0	8	16	19	36	10	6	2

Noise

Noise indicators		Sources										
		1	2	3	4	5	6	7	8	9	10	11
Noise emissions	Level of noise in terminals and industrial areas Lden (overall day-evening-night)	1					1	1	1	1	1	1
	Level of noise in terminals and industrial areas Lday (7:00 – 19:00 hrs)	1						1	1			
	Level of noise in terminals and industrial areas Levening (19:00-23:00 hrs)	1						1	1			
	Level of noise in terminals and industrial areas Lnight (23:00 – 7:00 hrs)	1						1	1			
	Level of noise in terminals and industrial areas Lday (7:00 - 22:00 hrs)								1			
	Level of noise in terminals and industrial areas Lnight (22:00 - 7:00 hrs)								1			
	Average noise exposure during an 8-hour working day	1										
	Maximum level of noise in terminals and industrial areas	1										
	Frequency of noise measurements	1										
	Existence of a noise-zoning map	1	1			1		1	1	1		
	Frequency of verification the noise-zoning map	1										
	Existence of a noise model		1									
	Level of noise in water due to vessels bunkering		1									
	Number of measures implemented to reduce noise levels	1					1			1		
	Noise levels in housing area around the port										1	
	Number of local residents affected by noise from port area operations	1										

	Percentage of survey respondents that perceive noise							1				
	Description of the port's main sources of noise emission							1	1			
	Existence of licence on noise issues for each terminal					1						
	The level of control on noise licence by authorities					1						
	Number of noise claims from authorities		1					1				
	Control of applying noise instructions					1						
	Total number of noise indicators: 22	11	4	0	0	1	6	5	10	4	2	1

Port development

Port development indicators		Sources										
		1	2	3	4	5	6	7	8	9	10	11
Port development	Has the port authority carried out an Environmental Impact Assessment (EIA) during the last 5 years?	1										
	Is the port involved with other organisations in the development of coastal or estuary management plans?	1										
	Has the port authority experienced, or does it anticipate any restrictions on development / expansion due to environmental planning controls?	1										
	Annual quantity or volume of dredged sediment	1	1						1			
	Annual amount of time and money spent on dredging activities	1				1						
	Frequency of dredging	1										
	Quantity of dredged sediment per fuel consumed	1										
	Number of research projects undertaken to evaluate both the short and the long term effects of dredging	1				1						
	Number of measures implemented to reduce negative ecological effects of dredging	1					1					
	Number of turtles harmed by dredging	1										
	Beneficial use of dredged material (definition and description of practices)	1							1			
	Percentage of dredged sediment going to beneficial use	1				1	1				1	
	Existence of facilities for the treatment and cleaning of the dredged sediments	1				1	1					
	Number of researchers and projects carried out concerning dredging disposal	1				1						
	Number of environmental licenses withdrawn or refused for dredging disposal	1	1									
	Frequency of monitoring in contaminated dredging material disposal sites	1	1				1					
	Measures dealing with the dredging disposal (storage, treatment, avoidance of pollution): definition of the measures and of the expected and current results	1										

	Measures to reduce negative ecological effects of dredging: definition of the measures and of the expected and current results.	1										
	Monitoring of the affected area after a capital dredging		1									
	Alteration of the sea floor											1
	Percentage of polluted dredging sediments								1	1	1	
	Total number of port development indicators: 21	18	4	0	0	5	4	0	3	1	2	1

Effects on biodiversity

Effects on biodiversity indicators		Sources										
		1	2	3	4	5	6	7	8	9	10	11
Effects on biodiversity	Is the port located in, or does it contain a designated protected area?	1										
	Area of land and water owned, leased, or (co)managed within designated protected areas	1	1	1			1		1			
	Description of significant impacts or activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas			1						1		
	Total area protected								1			
	Number of habitats protected or restored	1	1	1				1	1	1		
	Percentage of protected area								1			
	Area of Natura 2000 sites								1			
	Number of bird species protected								1			
	Number of flora species protected								1			
	Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the reporting organisation's discharges of water and runoff			1						1		
	Strategies, current actions, and future plans for managing impacts on biodiversity			1						1		
	Percentage of algae coverage at particular port sites	1	1					1	1			
	Percentage of change in the size of algae blooms at particular sites	1										
	Change of species diversity at particular sites	1										
	Other aquatic flora monitoring: quantity and variety of aquatic flora species	1						1				
	Trawling monitoring: quantity and variety of fish, crustaceans and other species which live on the seabed and within the water column	1					1		1			
	Benthic fauna monitoring: quantity and variety of benthic fauna found in sediments samples within the seabed	1	1			1		1				
	Birds monitoring: quantity and variety of farmland birds, woodland birds, water and wetland birds, and seabirds	1	1			1		1				

	Butterflies monitoring: quantity and variety of generalists (wider countryside) and specialists species of butterflies	1				1						
	Plant diversity: number of plant species per survey plot in arable land, woodland and grassland, and boundary habitats	1	1			1		1	1			
	Area of mangroves (various kinds of trees that grow in saline coastal sediment habitats)	1						1	1			
	Percentage of large fish	1	1			1		1				
	Annual number of fish deaths in a specific watercourse	1						1				
	Population of a specific animal species within a defined area	1							1			
	Number of International Union for the Conservation of Nature and Natural Resources (IUCN) Red List species and national conservation list species with habitats in port areas	1		1								
	Area of sensitive habitats exceeding critical loads for acidification and eutrophication	1										
	Number of widely established (more than 50 per cent) invasive species in freshwater, marine and terrestrial environments	1										
	Existence of a Special Protection Areas (SPA) monitoring scheme		1									
	Annual amount of time that people spend volunteering in biodiversity conservation	1										
	Heavy metals in fish samples							1	1			
	Number and description of initiatives implemented to protect and regenerate the natural environment								1			
	Area of contaminated land returned to productive use									1		
	Constructed on-land port area								1		1	
	Area of port water surface								1			
	Landscaped port area								1			
	Area dedicated to landfill, tourism or wetlands in the port area										1	
	Paved and non-fertile area in the port area										1	
	Measure of the erosion of topsoil in the port area										1	
	Crop yield over time from fields on the surrounding port area										1	
	Specific measures of the quality of habitat for specific species in the port area (fauna and flora)										1	
	Specific measures of the quantity of vegetation in the port area										1	
	Specific measures of the quality of vegetation in the port area										1	
	Number of total fauna species in the port area										1	
	Total number of effects on biodiversity indicators: 43	20	8	6	0	5	2	10	17	5	9	0

ANNEX III: CRITERIA TO ASSESS INDICATORS

Source	Criteria		
OECD (1993)	Policy relevance	Analytical soundness	Measurability
Ministry for the environment of New Zealand (1998)	Policy relevance Simple and easily understood	Measurable and analytically valid	Cost effective
De Leffe, et al (2003)	Policy relevant Practical	Informative Representative	Measurable
Verafaille, et al (2000)	Relevant and meaningful Inform decision makers Support benchmarking and monitoring	Clearly defined, measurable, transparent Be understandable and meaningful to stakeholders Recognize relevant and meaningful issues	Recognize the inherent diversity of business Based on the evaluation of operations, products and services
Dale, et al (2001)	Easily measured Integrative Respond to stress in a predictable manner	Sensitive to stresses Have low variability in response Predict changes	Have a known response to disturbances, anthropogenic stresses, and changes over time Be anticipatory
Jakobsen (2008)	Easy to understand Based on accessible data	Relevant	Reliable
EEA (2005)	Available and routinely collected data Understandability of indicators Policy relevance	Progress towards targets Methodologically well founded EU priority policy issues	Spatial and temporal coverage National scale and representativeness of data
UNEP (2003)	Policy relevant and meaningful Affordable modelling Broad acceptance	Biodiversity relevant Small number Sensitive Representative	Scientifically sound Affordable monitoring Aggregation and flexibility
EC (1998)	Be based on data adequately documented	Be based on readily available data or be	Be simple and easy to interpret

	and of known quality	available at reasonable cost	
	Be sensitive to the changes in the environment	Be capable of being updated at regular intervals	Scientifically valid
	Give early warning about irreversible trends	Representative	Show trends over time
Donnelly, et al (2007)	Be easily understandable to decision makers and the public	Well founded in technical and scientific terms	Cover a range of environmental receptors
	Policy relevant	Shows trends	Adaptable
	Relevant to the plan	Identify conflict	Prioritise key issues and provide early warning
Peris-Mora, et al (2005)	Representative ness	Conciseness	Purpose
	Adaptability	Comparability	Sensitivity
	Easy to obtain	Continuity	Regularity
	Cost-effectiveness	Scientific verification	Clarity
	Usefulness		
	Reliability and objectivity	Relevance	Well-defined limits

ANNEX IV: REGROUPED INDICATORS

This annex presents the indicators that were grouped. It shows the category where these indicators are categorized, the indicators that were rejected and the indicator obtained as a result of joining the previous ones.

Management

Category	Regrouped indicators	Resulting indicators
Environmental training & awareness indicators	Does the port authority have an environmental training programme for its employees?	Does the port authority have an environmental training programme for its employees?
	Existence of training (crane drivers, lift truck operators) with regard to noise	
Environmental communication indicators	Are there procedures to communicate environmental information internally between the key environmental personnel?	Are there procedures to communicate environmental information internally and externally?
	Are there procedures to exchange port environmental information with stakeholders including external parties?	
Emergency planning & response indicators	Does the port have an Emergency Response Plan?	Does the port have an Emergency Response Plan?
	Does the port have an Emergency Response Plan specially designed for handling hazardous cargo?	
	Does the port have a Cargo Handling Plan to avoid accidents?	
	Does the port have an Oil Spill Response Plan?	
	Does the port have a Water Leakage Response Plan?	
	Annual number of environmental accidents reported	Annual number of environmental accidents
	Annual number of accidents at the port sea area	
	Annual number of environmental incidents reported	Annual number of environmental incidents
	Annual number of incidents with the need for intervention	
EMS audits indicators	Number of EMS audits conducted	Number of EMS audits completed versus planned
	Number of EMS audits completed versus planned	
	Number of nonconformities found in EMS audits	Number of EMS audit nonconformities addressed versus found
	Number of nonconformities addressed	
Environmental legislation indicators	Compliance with discharges of wastewaters legal limits	Is the port in compliance with legislation legal limits?
	Compliance with discharges of oil legal limits	
	Compliance with discharges of particulate matter legal values	
	Compliance with discharges of sediments legal limits	
	Compliance with limits at day, evening, and night time for noise level	
Environmental	Total annual number of environmental complaints received	

complaints indicators	Annual number of dust-related complaints	Total annual number of environmental complaints received
	Annual number of odour-related complaints	
	Annual number of noise-related complaints	
	Annual number of dredging-related complaints	
	Number of inquiries or comments about environmentally related matters	
	Annual number of environmental complaints resolved where further action was necessary	Total annual number of environmental complaints resolved
	Number of environmental complaints filed, addressed, and resolved through formal complaints mechanism	

Air

Category	Regrouped indicators	Resulting indicators
Emissions of combustion gases	Total annual greenhouse gas (GHG) emissions	Total annual Carbon Footprint by scope
	Percentage of each scope contributing to the total emissions	
	GHG emissions per TEU	
	GHG emissions per number of employees	
Meteorological Data	Temperature	Meteorological Data
	Humidity	
	Surface wind pattern (direction, speed, intensity, frequency)	
	Rainfall	
	Atmospheric pressure	
	Solar Radiation	
	Cloudiness	

Water and sediments

Category	Regrouped indicators	Resulting indicators
Discharges of wastewaters	Dissolved Oxygen (DO)	Dissolved Oxygen (DO)
	Dissolved oxygen in surface waters	
	Dissolved oxygen in bottom waters	
	Inorganic ions	Inorganic ions
	Sulphate	
	Total Phosphorus	Nutrients
	Orthophosphates (dissolved inorganic phosphorus)	
	Total Nitrogen	
	Ammonium	
	Ammonia	
	Nitrite	
	Nitrate	
	Total coliform bacteria	Bacterial content
	Escherichia coli (E. coli)	
	Faecal coliforms	
	Faecal Streptococcus	
	Salmonella	
	Zooplankton	Plankton

	Bacterioplankton	
	Phytoplankton	
Discharges of other chemicals	Conductivity	Conductivity
	Water salinity	
Discharges of particulate matter	Total Dissolved Solids (TDS)	Solid content in water
	Total Suspended Solids (TSS)	
	Settleable solids	
Sediments Quality	Amount of organic matter	Total Organic Carbon (TOC)
	Total Organic Carbon (TOC)	
	Organic Carbon	
	Total Phosphorus	Nutrients
	Orthophosphates (dissolved inorganic phosphorus)	
	Total Nitrogen	
	Nitrite	
	Nitrate	
	Kjeldahl nitrogen	
	Ammonium	
	Calcium	
	Nutrients	

Soil

Category	Regrouped indicators	Resulting indicators
Emissions to soil and groundwater	Soil Organic Matter	Total Organic Carbon
	Total Organic Carbon	

Resource consumption

Category	Regrouped indicators	Resulting indicators
Energy consumption	Total annual energy consumption	Total annual energy consumption
	Total annual energy consumption by energy source	
	Percentage of each energy source	
	Percentage of energy consumption by use	
	Energy consumption per cargo handled	
	Energy consumption per number of employees	
Water consumption	Total annual water consumption	Total annual water consumption
	Total annual water withdrawal by source	
	Percentage of water withdrawal by source	
	Total annual water consumption by use	
	Percentage of water consumption by use	
	Total annual water consumption per cargo handled	
	Total annual water consumption per number of employees	
	Daily average water consumption for cleaning de port area	
Electricity consumption	Total annual electricity consumption	Total annual electricity consumption
	Electricity consumption per cargo handled	
	Electricity consumption per number of employees	
	Percentage of electricity consumption by use	

	Annual number of vessels connected to shore-side electricity	Annual number of vessels connected to shore-side electricity
	Percentage of vessels calling at the port that connect to shore-side electricity	
Fuel consumption	Total annual fuel consumption by type	Total annual fuel consumption
	Percentage of fuel consumption by type	
	Percentage of fuel consumption by use	
	Annual fuel consumption per number of employees	
	Annual fuel consumption per cargo handled	
	Total annual gas oil consumption	
Other resources	Total annual paper consumption	Total annual paper consumption
	Paper consumption per number of employees	

Waste production

Category	Regrouped indicators	Resulting indicators
Generation of waste	Percentage of disposal methods of port waste	Percentage of disposal methods of port waste
	Percentage of recycled waste	
	Existence of separate containers for the collection of port wastes	Existence of separate containers for the collection of port wastes
	Existence of separate containers for the collection of port recyclable garbage	
	Existence of separate containers for the collection of port hazardous waste	
	Existence of separate containers for the collection of port non-hazardous waste	
	Annual total amount of ship waste collected in ship waste reception facilities (Annexes of MARPOL convention)	Annual amount of ship waste collected by type of MARPOL annex
	Annual amount of ship waste MARPOL annex I (oil) collected	
	Annual amount of ship waste MARPOL annex II (noxious liquid substances carried in bulk) collected	
	Annual amount of ship waste MARPOL annex III (harmful substances) collected	
	Annual amount of ship waste MARPOL annex IV (sewage) collected	
	Annual amount of ship waste MARPOL annex V (garbage) collected	
Generation of recyclable garbage	Annual amount of port recyclable garbage collected by type	Amount of port recyclable garbage collected by type
	Percentage of each type of port recyclable garbage collected	
	Annual amount of port recyclable garbage recycled by type	Amount of port recyclable garbage recycled by type
	Percentage of each type of port recyclable garbage recycled	
Generation of hazardous waste	Annual amount of port hazardous waste collected by type	Amount of port hazardous waste collected by type
	Percentage of each type of port hazardous waste collected	
	Annual amount of port hazardous waste collected per number of employees	
	Annual amount of port hazardous waste collected per cargo handled	

	Annual amount of oil collected and recycled	
	Annual amount of port hazardous waste recycled by type	Amount of port hazardous waste recycled by type
	Percentage of each type of port hazardous waste recycled	
	Annual amount of oil collected and recycled	
Generation of non-hazardous waste	Annual amount of port non-hazardous waste collected by type	Amount of port non-hazardous waste collected by type
	Percentage of each type of port non-hazardous waste collected	
	Annual amount of port non-hazardous waste recycled by type	Amount of port non-hazardous waste recycled by type
	Percentage of each type of port non-hazardous waste recycled	

Noise

Category	Regrouped indicators	Resulting indicators
Noise emissions	Level of noise in terminals and industrial areas Lden (overall day-evening-night)	Level of noise in terminal and industrial areas
	Level of noise in terminals and industrial areas Lday (7:00 – 19:00 hrs)	
	Level of noise in terminals and industrial areas Levening (19:00-23:00 hrs)	
	Level of noise in terminals and industrial areas Lnight (23:00 – 7:00 hrs)	
	Level of noise in terminals and industrial areas Lday (7:00 - 22:00 hrs)	
	Level of noise in terminals and industrial areas Lnight (22:00 - 7:00 hrs)	
	Average noise exposure during an 8-hour working day	

Biodiversity

Category	Regrouped indicators	Resulting indicators
Effects on biodiversity	Is the port located in, or does it contain a designated protected area?	Total port area protected
	Area of land and water owned, leased, or (co)managed within designated protected areas	
	Total area protected	
	Number of habitats protected or restored	
	Percentage of protected area	
	Area of Natura 2000 sites	

ANNEX V: FINAL LIST OF INDICATORS

This annex presents all the indicators that remained until the end after the filtering process being already amended by the comments of the reviewers. They are classified according to the categories of environmental indicators. These resulting indicators are the ones that are coloured in green in Annex II (134) plus the ones that resulted from the regrouping process (39) (Annex IV), making a total of 173 indicators.

For the development of the TEIP tool, the resulting indicators were divided into four types of indicators:

	Qualitative indicators used as a question in the TEIP tool in order to demonstrate existence or inexistence of a specific environmental topic	24
	Qualitative indicators used as issues to take into account in the provision of recommendations	18
	Quantitative indicators used as output indicators of the TEIP tool	129
	Indicators rejected in the application of the TEIP tool.	2

Environmental management indicators	
Environmental Management System	Does the Port have a certified Environmental Management System (EMS)?
	Has the port completed the environmental review Self Diagnosis Method?
	Is there a procedure to review the port's EMS program?
Environmental Policy	Does the port have an Environmental Policy?
	Is the policy communicated to all employees?
	Is the policy publicly available on the port's website?
	Does the policy aim to improve environmental standards beyond those required by legislation?
Objectives and targets	Has the port defined objectives for environmental improvement?
	Does the port have quantitative objectives?
	Number of environmental objectives defined
	Percentage of environmental objectives achieved
	Have management programmes and action plans been prepared to achieve each objective?
Environmental monitoring plan	Does the port have an environmental monitoring plan?
	Has the port identified environmental indicators to monitor trends in environmental performance?
	Number of environmental indicators monitored
Significant Environmental Aspects	Does the port have an inventory of Significant Environmental Aspects?
	Are there procedures to maintain and update the inventory of SEA?
	Number of Significant Environmental Aspects identified
Management organisation & personnel	Does the port have a representative responsible for managing environmental issues?
	Does the representative ensure compliance with environmental policy?
	Are the environmental responsibilities of this representative documented?
	Percentage of employees working on environmental issues
Environmental training & awareness	Does the port authority have an environmental training programme for its employees?
	Has the port authority established procedures for identifying training needs?
	Frequency of environmental training sessions for port employees
	Percentage of port employees that received environmental training
	Annual number of training hours per employee
Environmental communication	Does the port publish a publicly available Environmental Report?
	Are there procedures to communicate environmental information internally and externally?
	Annual number of environmental reports published

	Annual number of press articles published concerning environment
	Does the port website show environmental information?
	Annual number of conferences that the port authority has organized or participated in
	Number of environmental educational programmes or materials provided for the community
Emergency planning & response	Does the port have an Emergency Response Plan?
	Does the plan specify the communication, control and containment procedures?
	Does the plan specify the location and type of equipment (on and off site)?
	Does the plan specify the location and skills of trained personnel (on and off site)?
	Number of times that the Emergency Response Plan has been activated
	Total number and volume of (significant) oil and chemical spills
	Annual number of environmental accidents
	Annual number of environmental incidents
	Does the port have a representative responsible for managing safety issues?
	Has the port authority carried out an Environmental Risk Assessment during the last 5 years?
EMS audits	Has an external EMS audit been conducted?
	Number of EMS audits completed versus planned
	Number of EMS audit findings
	Number of EMS audit nonconformities addressed versus found
Environmental legislation	Does the port have an inventory of relevant environmental legislation and regulations related to its liabilities and responsibilities?
	Are there procedures to maintain and update the inventory of environmental legislation?
	Are there methods to deal with non-compliance with internal and external standards?
	Number of fines received for non-compliance with environmental legislation
	Number of times that the daily limit value of a certain environmental parameter has been exceeded
	Is the port in compliance with legislation legal limits?
Environmental complaints	Total annual number of environmental complaints received
	Total annual number of environmental complaints resolved
Environmental budget	Does the port have a budget specifically for environmental protection?
	Total annual budget allocated to environmental protection
	Percentage of the budget allocated to environmental protection out of the total budget
	Percentage of annual variation in the environmental budget

Emissions to air indicators	
Emissions of combustion gases	Does the port measure or estimate its Carbon Footprint?
	Total annual Carbon Footprint by scope
	Frequency of monitoring the Carbon Footprint in the port area
	Percentage of each energy source contributing to the Carbon Footprint
	Percentage of annual change in the Carbon Footprint
	Does the port differentiate dues for 'Greener' vessels?
	Carbon monoxide (CO)
	Nitrogen oxides (NO_x)
	Sulphur dioxide (SO_2)
Emissions of other gases	Ammonia (NH_3)
	Dioxins
	Heavy metals
	Ozone
	Volatile Organic Compounds (VOCs)
	Benzene
	Polychlorinated biphenyl (PCB)
	Frequency of photochemical smog events
	Persistent Organic Pollutants (POPs)

	Polycyclic Aromatic Hydrocarbons (PAHs)
Emissions of particulate matter	Dust
	PM10
	PM2.5
Odour emissions	Hydrogen sulphide (H_2S)
	Percentage of respondents that perceive odour
Meteorological data	Meteorological Data

Discharges to water/sediments indicators	
Discharges of wastewaters	Chlorophyll
	Biological Oxygen Demand (BOD)
	Chemical Oxygen Demand (COD)
	Algal Growth Potential (AGP)
	Dissolved Oxygen (DO)
	Inorganic ions
	Nutrients
	Bacterial content
	Water pH
	Redox potential
	Total hardness
	Total Organic Carbon (TOC)
	Total Oxygen Demand (TOD)
	Water colour
	Water temperature
	Plankton
Discharges of hydrocarbons	Oil Content (Hydrocarbons)
	Volatile Organic Compounds (VOCs)
Discharges of other chemicals	Halogen content
	Conductivity
	Heavy metals
	Surfactants
	Tributyltin (TBT)
Discharges of particulate matter	Solid content in water
	Turbidity (water transparency)
Sediments quality	Persistent Organic Pollutants (POPs)
	Polychlorinated biphenyl (PCB)
	Polycyclic Aromatic Hydrocarbons (PAHs)
	Tributyltin (TBT)
	Redox potential
	Total Organic Carbon (TOC)
	Volatile Organic Compounds (VOCs)
	Nutrients
	Heavy metals
	Sediments particle size distribution

Emissions to soil indicators	
Emissions to soil and groundwater	Electrical conductivity
	Soil pH
	Macronutrients
	Total Organic Carbon (TOC)
	Total port area with soil pollution
	Heavy metals
	Redox potential

Resource consumption	
Energy consumption	Total annual energy consumption
	Percentage of the annual variation in the energy consumption
	Percentage of renewable energy per total energy consumed

Water consumption	Total annual water consumption
	Annual amount of recovered rainwater
	Percentage of the annual variation in the water consumption
	Percentage of water recycled per total water consumption
Electricity consumption	Total annual electricity consumption
	Is Onshore Power Supply (OPS) available at one or more of the berths?
	Annual number of vessels connected to shore-side electricity
Fuel consumption	Total annual fuel consumption
	Is Liquefied Natural Gas (LNG) bunkering available in the port today?
Other resources	Total annual paper consumption

Waste production indicators	
Waste generation	Total annual port waste collected
	Total annual port waste recycled
	Percentage of disposal methods of port waste
	Existence of separate containers for the collection of port wastes
	Existence of ship waste reception facilities
	Annual waste collected on port surface water (Anthropogenic debris)
	Annual amount of ship waste collected by type of MARPOL annex
Generation of recyclable garbage	Amount of port recyclable garbage collected by type
	Amount of port recyclable garbage recycled by type
Generation of hazardous waste	Amount of port hazardous waste collected by type
	Amount of port hazardous waste recycled by type
Generation of non-hazardous waste	Amount of port non-hazardous waste collected by type
	Amount of port non-hazardous waste recycled by type

Noise indicators	
Noise emissions	Level of noise in terminal and industrial areas
	Maximum level of noise in terminals and industrial areas
	Frequency of noise measurements
	Existence of a noise-zoning map
	Noise levels in housing area around the port
	Percentage of survey respondents that perceive noise
	Number of noise claims from authorities

Port development indicators	
Port Development	Has the port authority carried out an Environmental Impact Assessment (EIA) during the last 5 years?
	Annual quantity or volume of dredged sediment
	Frequency of dredging
	Percentage of dredged sediment going to beneficial use
	Existence of facilities for the treatment and cleaning of the dredged sediments
	Percentage of polluted dredging sediments

Effects on biodiversity indicators	
Effects on biodiversity	Total port area protected
	Number of bird species protected
	Number of flora species protected
	Percentage of algae coverage at particular port sites
	Percentage of large fish
	Heavy metals in fish samples
	Area of contaminated land returned to productive use

ANNEX VI: EXAMPLES OF GUIDELINES

Guidelines for management and operational indicators

<table>
<tr><td>Indicator's name</td><td colspan="3">Percentage of disposal methods of port waste</td></tr>
<tr><td>Category</td><td>Waste production indicators</td><td>Indicator's code</td><td>G.22.3</td></tr>
<tr><td>Sub category</td><td colspan="3">Waste generation</td></tr>
<tr><td>Definition</td><td colspan="3">This indicator monitors the disposal methods of the waste collected at the port area, based on the percentage of waste destined to each method. The main methods of waste treatment are [1]:
- Controlled landfills
- Composting
- Recycling
- Incineration
- Uncontrolled landfills
- Other methods</td></tr>
<tr><td>Importance</td><td colspan="3">Not all the methods of waste disposal have the same impact on the environment. For example, recycling of waste and composting have a lower environmental impact in comparison to controlled landfills or incineration. At the same time, these two latter methods are more environmentally friendly than uncontrolled landfills.</td></tr>
<tr><td>Units of measurement</td><td colspan="3">This indicator is expressed as the percentage of each disposal method. In order to obtain this result, the amount (tonnes/year) for each method is needed.
<table>
<tr><th>Disposal method</th><th>Amount (t/year)</th><th>% of the total</th></tr>
<tr><td>Controlled landfills</td><td></td><td></td></tr>
<tr><td>Composting</td><td></td><td></td></tr>
<tr><td>Recycling</td><td></td><td></td></tr>
<tr><td>Incineration</td><td></td><td></td></tr>
<tr><td>Uncontrolled landfills</td><td></td><td></td></tr>
<tr><td>Other methods</td><td></td><td></td></tr>
<tr><td>Total</td><td></td><td>100%</td></tr>
</table></td></tr>
<tr><td>Frequency</td><td colspan="3">Annually</td></tr>
<tr><td>Level of effort</td><td colspan="3">High level: the information required by the indicator is specific and it may require a deep research to be obtained.</td></tr>
<tr><td>References</td><td colspan="3">[1] WORLD BANK. What a Waste: A global review of solid waste management. Urban Development Series - Knowledge Series. [http://siteresources.worldbank.org/INTURBANDEVELOPMENT/Resources/336387-1334852610766/Chap6.pdf, 20th of March 2016]</td></tr>
</table>

<table>
<tr><td>Indicator's name</td><td colspan="3">Annual waste collected on port surface water (Anthropogenic debris)</td></tr>
<tr><td>Category</td><td>Waste production indicators</td><td>Indicator's code</td><td>G.22.4</td></tr>
<tr><td>Sub category</td><td colspan="3">Waste generation</td></tr>
<tr><td>Definition</td><td colspan="3">This indicator monitors the amount of solid waste collected in the surface of port waters, by specialized vessels.</td></tr>
<tr><td>Importance</td><td colspan="3">Debris floating on the surface of the port waters pollute the water and generate opacity and loss of light available for photosynthesis of aquatic organisms [1]. In addition, floating wastes generate serious visual and aesthetic impact in the port.</td></tr>
<tr><td>Units</td><td colspan="3">Kg/year</td></tr>
<tr><td>Frequency</td><td colspan="3">Annually</td></tr>
<tr><td>Level of effort</td><td colspan="3">Intermediate level: the information required by the indicator is not very complex, but it requires certain research to be obtained.</td></tr>
</table>

References	[1] GREENPEACE. *Plastic Debris in the World's Oceans*. Amsterdam, Greenpeace International.

Guidelines for condition indicators

Indicator's name	Carbon monoxide (CO)		
Category	Emissions to air	**Indicator's code**	G.1.1
Sub category	Emissions of combustion gases		
Definition	Carbon monoxide (CO) gas is odourless, colourless and tasteless. The main source of emission of CO is produced by incomplete combustion in internal combustion engines of cars, trucks and airplanes. Other major sources of emissions are energy production, industrial processes or fires [1].		
Importance	CO is an important component of urban air pollution and pollution inside buildings as it has harmful effects on human health in short term. Additionally, although the CO is not a greenhouse gas, its oxidation to CO_2 may have adverse effects on the global climate [1].		
Units of measurement	- Milligrams of CO per cubic meter of air (mg/m3) [2] - Parts per million (ppm) [2]		
Equivalence	$$ppm \cdot \frac{M}{24{,}4} = mg/m^3$$ where: *M*: Molecular mass of the substance (28 g/mol for CO) *24,4:* volume of a mol (l/mol) of an ideal gas at 1 atm and 25ºC [2]		
Description of the methodology	Below, a method is presented for determining the concentration of CO in the ambient air through the nondispersive infrared (NDIR) absorption [3]. **Basis:** The NDIR technique is a method designed for the continuous monitoring and it is based on the absorbance of the infrared radiation characteristic of the CO molecule at λ = 4.6 μm. This absorbance may be used to measure the concentration of CO even in the presence of other gases. **Equipment needed:** - Sampling system: it is necessary to collect samples of air from the atmosphere and lead them to the analyser, without altering their composition. It consists of the following elements: - Sampling probe - Suction tube - Pipes (tubes) - Pump for the air suction - Analysis system: it is composed of the following elements: - NDIR analyser (measures the CO absorbance at λ = 4.6 μm) - Humidity control system (e.g. Nafion® drying column [4]) - Particulate filter (to prevent suspended particulates to enter to the cell detection) - Flowmeter (to know the volume of sample) - Data recording system: system capable of recording data in a standard format.		
Limit values	10 mg / m3, maximum average concentration for 8 hours [5].		
Monitoring locations	Usually, measuring stations are located at a height of 3 to 10 meters, in a point sufficiently far from the source of emission of the pollutant [6].		
Frequency	Monitoring 24 hours a day throughout the year (see note) [3].		
Approximate cost	Sampling system: 500 € [7] NDIR analyser: 5.400 € [8] Data recording system: 97 € [9]		
Notes	During the monitoring, it is frequent to have a loss of 5 to 10% of the data at the end of the year (for maintenance, breakdowns, etc.) [3].		
References	[1] JACOBSON, M. Atmospheric pollution: History, science, and regulation. Cambridge, Cambridge University Press, 2002.		

[2] A. RAÑA. *Unidades de medición empleadas en Calidad del Aire*. La Coruña, 2002
[3] BVSDE. Chapter 02, Analytical Methods for Monitoring Carbon Monoxide. Washington, Organización Panamericana de la Salud, 2005.
[4] CHROMSERVIS. *Dryer Nafion, 1 tube 0.07", 144" length, SS shell/fittings* [https://www.chromservis.eu/p/dryer-nafion-1-tube-0-07-144-length-ss-shell-fittings, 6th of March 2016]
[5] EUROPEAN COMMISSION (EC). *Directive 2000/69/EC of the European Parliment and of the Council of 16 November 2000 relating to limit values for benzene and carbon monoxide in ambient air*. Brussels, Official Journal of the European Communities, 2000.
[6] INDIAN INSITITUTE OF TECHNOLOGY GUWAHATI. QUALITY IMPROVEMENT PROGRAMME. *Air Pollution Sampling and Analysis*. Guwahati, Departmen of Civil Engineering, 2009.
[7] LABX. *Air sampling listings*. 2016. [http://www.labx.com/air-sampling, 6th of March 2016]
[8] THERMOCIENTIFIC. *NDIR Model 60 Multi-Gas Analyzer*. 2015 [http://www.thermoscientific. com/en/product/ndir-model-60-mult-gas-analyzer.html, 6th of March 2016]
[9] LABJACK. MEASUREMENT & AUTOMATION. *U3 Series*. 2015 [https://labjack.com/ products/u3, 6th of March 2016]

Indicator's name	Nitrogen oxides (NOx)		
Category	Emissions to air	**Indicator's code**	G.1.2
Sub category	Emissions of combustion gases		
Definition	This indicator measures the concentration of the nitrogen oxides (NO_X) in the air. The parameter NO_X mainly includes the gases NO and NO_2 (nitrogen monoxide and nitrogen dioxide, respectively). Nitrogen monoxide is a colourless gas, and nitrogen dioxide is a brownish gas that gives off a strong odour. The main source of NO emissions are the combustion processes at high temperature and the main source of NO_2 is the oxidation of NO. NO_2 is also created in the combustion process, but in very small quantities compared to the emissions of NO [1].		
Importance	Nitrogen oxides have adverse effects on the environment: they are precursors of ozone (the main component of photochemical smog) and nitric acid, one of the substances that cause acid rain. Additionally, both NO and NO_2 reduce stratospheric ozone.		
Units of measurement	- Microgram of NO_2 per cubic meter of air (µg/m3) - Parts per billion (ppb) [2]		
Equivalences	$$ppb \cdot \frac{M}{24{,}4} = \mu g/m^3$$ where: M: Molecular mass of the substance (46 gr/mol for NO_2) *24,4:* volume of a mol (l/mol) of an ideal gas at a pressure of 1 atm and a temperature of 25ºC [2]		
Description of the methodology	The standard method proposed by the European Committee for Standardization (CEN) to determine the concentration of nitrogen dioxide and nitrogen monoxide in ambient air is based on the chemiluminescence technique [3]. **Basis:** The principle of chemiluminescence is based on the fact that NO is a relatively unstable molecule that is oxidized to NO_2 in the presence of ozone (O_3). This reaction produces an exact amount of light for each molecule of NO that reacts. The light emitted can be measured. By controlling the volume of the sample and the excess O_3, the level of luminescence in the reaction chamber is directly proportional to the concentration of NO in the sample. Since the device only		

	detects NO, in order to determine the concentration of NO_2 or total nitrogen oxides (NO_X), there must be a previous reduction to NO [4]. Equipment and specifications: The equipment APNA-370 Ambient NOx Monitor [5] is able to determine the concentration of nitrogen oxides in the atmosphere using the CEN standard method. **Specifications of the equipment [5]** - This device has a single detector to determine the amounts of NO, NO_2 and NO_x continuously. - The standard equipment of the device includes a drying unit with an automatic air recycling device to provide dry ambient air and a constant source of ozone. - The equipment includes a silicon photodiode as a sensor light radiation.
Limit values	- 200 μg/m3, maximum concentration of NO_2 in 1 hour [6] - 40 μg/m3, annual average concentration of NO_2 [6]
Monitoring locations	Usually, measuring stations are located at a height of 3 to 10 meters, at a point sufficiently far from the source of emission of the pollutant [7].
Frequency	Monitoring 24 hours a day throughout the year
Approximate cost	APNA-370 Ambient NO_X Monitor: 10.890 € [5]
References	1] JACOBSON, M. Atmospheric pollution: History, science, and regulation. Cambridge, Cambridge University Press, 2002. [2] A. RAÑA. *Unidades de medición empleadas en Calidad del Aire*. La Coruña, 2002 [3] *CEN. EUROPEAN COMMITTE FOR STANDARIZATION. EN 14211:2012. Ambient air - Standard method for the measurement of the concentration of nitrogen dioxide and nitrogen monoxide by chemiluminescence*. 2012 [http://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT: 31489&cs=121328E210D8394411592163411159 17E, 6th March 2016] [4] K2BW. *Chemiluminescent Measurement of NO/NOx in Gas Analysers*. New York, 2013.[http://www.k2bw.com/chemiluminescence.htm, 6th of March 2016] [5] HORIBA. PROCESS & ENVIRONMENTAL. *APNA-370 Ambient NOx Monitor*. 2016. [http://www.horiba.com/process-environmental/products/ambient/details/apna-370-ambient-nox-monitor-274/, 6th of March 2016] [6] EUROPEAN COMMISSION (EC). *Council Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air*. Brussels, Official Journal of the European Communities, 1999. [7] INDIAN INSITITUTE OF TECHNOLOGY GUWAHATI. QUALITY IMPROVEMENT PROGRAMME. *Air Pollution Sampling and Analysis*. Guwahati, Departmen of Civil Engineering, 2009.

ANNEX VIII: EXAMPLES OF RECOMMENDATIONS

<table>
<tr><td>Recommendation</td><td>To monitor the GHG emissions (Carbon Footprint)</td><td>Recommendation code</td><td>R.1.1</td></tr>
<tr><td>Definition</td><td colspan="3">The Carbon Footprint is a measure of the total amount of greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organisation, event or product. Carbon Footprint accounts for all six Kyoto GHG emissions: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). The results are given in tonnes of carbon dioxide equivalent (CO_2e). This is the unit of measurement which allows different greenhouse gases to be compared on a like for like basis relative to one unit of CO_2. CO_2e emissions are calculated by multiplying the emissions of each of the six greenhouse gases by its 100 year global warming potential (GWP) [1]. For example, the 100 year GWP of methane is 34, so it means that methane emissions are multiplied by 34 in order to convert them into CO_2e.</td></tr>
<tr><td>Contents</td><td colspan="3">The calculation of the Carbon Footprint of an organisation encompasses a wide range of emissions sources. The Greenhouse Gas Protocol (GHG Protocol) classifies the GHG emissions by the level of control an organisation has over them. On this basis, there are three main types, known as scopes [1]:
Scope 1: Direct emissions that result from the activities that the organisation controls
These include stationary sources (operational machines and cranes, heating or cooling) and mobile sources (company owned vehicles such as cars or vessels).
Scope 2: Emissions from electricity usage
It includes electricity used for harbour lightning, and for the heating and lightning of the buildings. It also includes electricity usage by cranes, lighthouses, or electricity usage for other purposes. Although the organisation is not directly in control of the emissions, by using the electricity it is indirectly responsible for the release of CO_2.
Scope 3: Indirect emissions from sources that the organisation does not directly control
Examples of scope 3 include the employees' commuting and the employees' business travel.
With regards to the calculation of the Carbon Footprint, all Scope 1 and Scope 2 emissions should be included in the calculation, but the authority can choose which Scope 3 emissions includes, if any, because it is considered as 'voluntary' by the GHG Protocol.
An increasing number of port authorities are committing themselves to calculating, quantifying and reporting their Carbon Footprint. There are two main reasons for calculating the Carbon Footprint [1]:
• To identify the key emission sources and to discover opportunities to reduce their emissions. Reducing an organisation's Carbon Footprint may result in cost savings and could lead to competitive advantages and market differentiation.
• To report the footprint accurately to a third party. Companies are calculating their carbon footprint in order to share the information with other organisations (for public disclosure), to report emissions as part of a Corporate Social Responsibility (CSR) programme or for marketing purposes, to respond to requests from business, customers and investors or to ascertain what level of emissions are needed to offset in order to become 'carbon neutral'.
This calculation also may be independently verified to ensure that the methodology has been correctly used and that the results are accurate.</td></tr>
</table>

Recommended indicators	There are four quantitative indicators related to the monitoring of the Carbon Footprint recommended in TEIP: • Total annual greenhouse gas (GHG) emissions by scope (Carbon Footprint) • Frequency of monitoring the GHG emissions (Carbon Footprint) in the port area • Percentage of each energy source contributing to the carbon footprint • Percentage of annual change in greenhouse gas (GHG) emissions In addition, the indicator 'Total annual greenhouse gas (GHG) emissions by scope' could be reported in a standardised common ground: • Greenhouse gas emissions by annual tonnes of cargo handled • Greenhouse gas emissions by annual TEUs • Greenhouse gas emissions by number of port employees Another indicator that was regrouped was the following one: • Percentage of each scope contributing to the total emissions
Example	The Environmental Report 2014 of the Port of Valencia details the methodology followed to calculate its Carbon Footprint and the total annual CO_2e emissions [2].
Objective No. 45. Calculating the Port of Valencia's carbon footprint The carbon footprint for the Port of Valencia was calculated for 2010 and 2012, and was validated using the method established in the Climeport project, which was also used to calculate the port's carbon footprint for 2008. The method was validated by a certification body, in accordance with the requirements set out in ISO 14064. The calculation was based on the following scopes: Scope 1: The PAV's direct GHG emissions Scope 2: The PAV's indirect GHG emissions Scope 3: Other PAV indirect GHG emissions - Indirect emissions from diesel consumption by concessionaires at the port. - Indirect emissions from natural gas consumption by concessionaires at the port. - Indirect emissions from fuel consumption deriving from goods transport within the port facility. - Indirect emissions from fuel consumption deriving from ships' calls Thus, the data obtained so far in kilos of CO_2 equivalent per tonne of goods throughput are as follows: - 2008: 3.12 - 2010: 2.78 - 2012: 2.66	
References	[1] Carbon Trust. 2012. *Carbon Footprinting. The next step to reduce your emissions.* [Online]. Available at: https://www.npower.com/idc/groups/wcms_content/@wcms/documents/digitalassets/eskh_pdf_carbon_footprinting.pdf [2] Environmental Report 2014. Valenciaport. Autoridad Portuaria de Valencia.

Recommendation	To differentiate dues for 'Greener' vessels	**Recommendation code**	R.1.2
Definition	It consists that the port authority provides environmentally differentiated port fees as a financial incentive to support and encourage shipping companies to try and reduce environmental impact themselves [1].		
Contents	More and more, port authorities apply environmentally differentiated port fees to encourage shipping companies to take environmental measures that go beyond the legal requirements. The main objective is to reduce both the local air pollution from ships (primarily related to emissions of NO_X, SO_2, particles, noise and chemicals and oils to		

	water) and the pollution with global impact (primarily related to emissions of CO_2 and particles) [1]. To motivate and encourage ship owners to reduce their environmental impact, ports are introducing new environmental discounts for 'greener' vessels, such as: • Vessels that are able to connect to electricity at the quayside (Onshore Power Supply), since it is demonstrated that connecting vessels to shore side electricity reduces noise pollution and emissions to the atmosphere [2] • Vessels fuelled with LNG, since they do not emit SO_2 or particles into the atmosphere. In addition, these vessels emit reduced emissions of CO_2 and NO_x,(85% less) [2] • Vessels that comply with a voluntary speed limit in the port authority's waters as a way to reduce ships' emissions [3]. • Vessels that report good environmental performance, for instance on the Environmental Ship Index (ESI) [4], the Clean Shipping Index (CSI) [5] or on the Green Award [6].
Example	Ports of Stockholm has applied environmentally differentiated port fees since the 1990s. The discounts that this port authority provides to shipping companies are described below [7]:

Prices for services/tariffs

From 2015 Ports of Stockholm will apply new environmentally differentiated fees to encourage shipping companies to implement environmental initiatives over and above the legal requirements.

In summary the environmental rebates are the following:

- A funding contribution of SEK 1 million will be offered to every vessel that carries out restructuring work to enable the vessel to connect to electricity at the quayside. This applies for the quays where Ports of Stockholm offers quayside electricity connection capabilities.
- The port fee for LNG vessels will be discounted by 5 öre per unit of gross tonnage. For a vessel of the size of Viking Grace, calling at Stockholm daily, this amounts to a rebate of around SEK 1 million annually. For a vessel calling at Stockholm every second day the rebate will be around SEK 500 thousand annually.
- The discount for reduced emission of nitrous oxide will follow the seven-level scale applied by the Swedish Maritime Administration. For a normal-sized vessel operating daily calls this will mean a discount of between SEK 3 million to SEK 4 million annually, depending on the amount of nitrous oxide emissions.

References	[1] CLEANSHIP. 2013. Clean Baltic Sea Shipping. Project Report. [2] GREEN4SEA. 2014. Ports of Stockholm applies differentiated port fees for LNG vessels [Online] Available at: http://www.green4sea.com/ports-of-stockholm-applies-differentiated-port-fees-for-lng-vessels/ [3] OECD, 2011. [4]: http://www.environmentalshipindex.org/Public/Home [5] http://www.cleanshippingindex.com/ [6] http://www.greenaward.org/greenaward/ [7] Ports of Stockholm. 2015. Prices for services / tariffs. [Online] Available at: http://www.portsofstockholm.com/about-us/prices-for-servicestariffs/