A METHODOLOGICAL APPROACH TO MANAGE CONTAMINANT EVENTS IN SEAPORT WATER BODIES: APPLICATION TO THE PORT OF TARRAGONA

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ABSTRACT

The Water Framework Directive (WFD, 2000/60/EC) develops a framework for the protection of continental, coastal and transitional waters, so it has a direct effect on port water bodies, since ports are within the space scope of the WFD. For this reason, the Spanish National Port Administration (Puertos del Estado) considered it beneficial to develop the first methodological and technical tool for the integral management of water bodies, so-called "Quality of coastal waters in port areas (ROM 5.1)". This recommendation appears within this context with the purpose of carrying out a sustainable development in port areas in order to protect and improve their aquatic environment. This methodological approach consists on four programmes: the delimitation of uses and characterization of water bodies, the environmental risk assessment, the environmental monitoring and the management of contaminant events, in order to cover all the environmental aspects related with port activity. Specially, the last one allows establishing a general procedure with the aim to lead the mitigation of quality deficits detected in water bodies. In order to improve the management of contaminant events in port water bodies, it is necessary a more detailed methodological approach which should involve the control of contaminant events from port activities and implement an integral management procedure. In this paper it is described the developed methodology.

According to this, the methodological approach has been improved with new steps to manage contaminant events. Firstly, a visual inspection plan allows the detection of contaminant events. When an event has been detected, it is classified according to its dangerousness and to the kind of substance spilt into the water. Following, an action – actuation plan is applied with the aim of minimizing the effects of the contaminant event. Finally, a recovery plan is implemented to verify the real impact of affected water bodies by the contaminant event. Once the water bodies have been recovered, the event is registered using a standard registration form.

This methodological approach has been applied to the management of contaminant events detected in the Port of Tarragona, located in the northeast of the Mediterranean Sea, as is described in this paper.

INTRODUCTION

Harbours are littoral structures that, historically, have been working as meeting points between the land and maritime transport.

Harbours represent an anthropic pressure because they are usually connected with a high industrial activity. For this reason, as the presence of ports is associated with coastal ecosystem degradation, the developments of methodologies that preserve and improve the port water quality are necessary. (Ondiviela, 2006).

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The European harbours have worked from the begin of the nineties to nowadays in the environmental management field (Ondiviela, 2006). There are different regulations, the most important outcome in Europe has been the Water Framework Directive (WFD, 2000), that develops a system of integral management for the protection of European aquatic ecosystems. The WFD includes the port waters. (European Commision, 2001).

In this context, it appears the recommendation ROM 5.1 “Quality of coastal waters in seaport areas” with the aim of improving the sustainable development of aquatic systems, (Ondiviela, 2006). This recommendation is structured in four working areas: The delimitation of uses and characterization of water bodies programme, the environmental risk assessment programme, the environmental monitoring programme and the management of contaminant events programme, (ROM 5.1 programme).

There is not exist a standard way to manage the port contaminant events, this management is carried out in accordance with port requirements and structures. For that reason, there are harbours that exhibit an absence of recorded information about contaminant events, even more, sometimes, when such records exist, they are not homogeneous.

The main problem related with the management of contaminant events is the incomplete information in the records. In other words, usually there is a lack of data related with the location, the spilled product or the origin of the event.

In some harbours, the detection of the contaminant events is carried out through visual inspection and, in others; it is executed through the reports of any sector of the population. The minority system for the detection of contaminant events is represented by the direct notification of the contaminant event generator. It involves the no interaction between the company and the harbour.

Based on these facts, the main objective is to develop a methodological procedure in order to manage efficiently potential contaminant events in water ports. To achieve this goal, some specific aims need to be detailed.

OBJECTIVES

To develop a visual inspection plan in order to detect as soon as possible the contaminant event. To establish a classification of contaminant events to manage the stage of contingency. To establish the action – actuation plan. To establish a recovery plan to evaluate the recovery of the seaport water body affected.

METHODOLOGICAL DEVELOPMENT

In the present work it is proposed a methodology that uses a visual inspection plan to detect the contaminant event. In accordance with this methodological proposal, once a contaminant event is detected, it will be classified by two parameters: the kind of the substance spilled and the type of the dangerous event. Once the contaminant event has been classified, the action – actuation plan has to be applied. Additionally, if it is detected a dangerous or very dangerous event, the recovery plan will be applicated until the environment is recovered (figure 1).

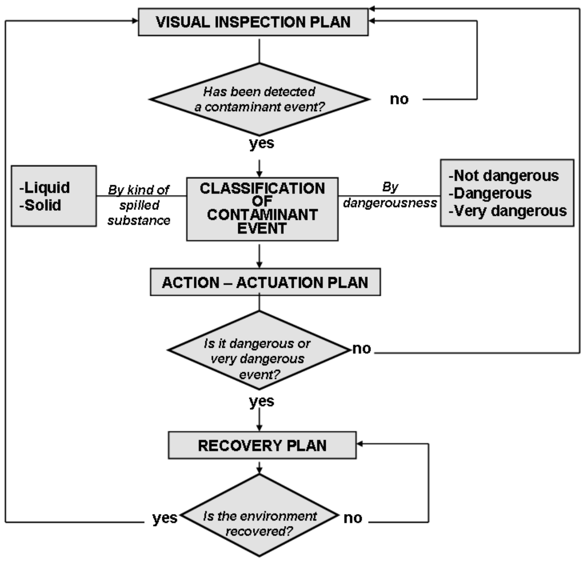

Figure 1. Methodological diagram

1. Visual Inspection Plan

The visual inspection plan is integrated by activities focused on the detection of contaminant events. (ESPO, 2003).

The Spanish law 48/2003 distinguishes two areas: the zone I are the Port's interior waters shield naturally or artificially, including the docks destined to loading and unloading, transfer of goods, embarkation and disembarkation of passenger, ship building and refitting, as well as the areas necessary for the manoeuvres of docking and the water spaces within the breakwaters. The zone II are surface making up the rest of the port waters and whose main use is for access and anchorage.

At this stage, the visual inspection plan is designed by persons that watch the harbours.

The visual inspection plan is the visual detection of the effects derived from the introduction of contaminants in the port water environment.

The visual inspection plan establishes three types of inspection according to the environment where the inspection is done: land, sea or air.

The visual inspection made by land involves foot or vehicle checking. The visual inspection by sea involves boat checking. The visual inspection by air involves checking by cameras located in many points of the harbour.

Therefore, a previous environmental checking of the activities developed in the port should be done. Based on the detected types of contaminant events related with port activities, there are established levels in accordance with the frequency of occurrence of the contaminant events and the dangerousness of the involved products. (Saez J.,2002 ; Peris – Mora, E., 2005). The frequency may be low, medium or high. The dangerousness may be not dangerous, dangerous or very dangerous, (Darbra R.M, 2004). In this context, the different levels are established as shown in figure 2.

Frequency / Dangerousness	High (usually)	Medium (possibly)	Low (casually)
Very dangerous (toxic substance)	**Red**	**Red**	**Yellow**
Dangerous (bacteriologic and O2 consumer substances)	**Red**	**Yellow**	**Green**
Not dangerous (aesthetic substance)	**Yellow**	**Green**	**Green**

Figure 2. Levels of Visual Inspection

The green level includes the checking of the specific docks where the activities are developed. This check consists of the water surface zone inspection. This inspection should be intensified at the most hard work hours.

The yellow level includes the checking by shift works, intensified at the most hard work hours, and at the arrival and departure of the products.

The red level is the hardest checking. This level involves the inspection of two persons at the place from the beginning to the end of the activity. The red inspection should be intensified with maritime inspections at the water bodies. (Goulielmos, A.M., 2000).

To carry out the visual inspection a standard form is used which records the following information:

1. General facts
2. Detection system
3. Characteristics product
4. Type of contamination
5. Location
6. Causes
7. Meteorological conditions

2. Classification of contaminant event

The classification of a contaminant event will be activated when it is detected. The classification lets manage the resources to solve the contaminant events. It is established by two criteria specified at the previous standard form filled during the visual inspection plan. These criteria are: the kind of the spilled substance and the dangerousness of the event. (Autoridad Portuaria de Tarragona, 2004 - 2005).

Firstly, the spilled substance could be liquid or solid. In accordance with the composition, there are 3 kinds of liquids:

1. Hydrocarbons: chemical products that contain carbon and hydrogen (petroleum and crude oil).
2. Chemicals: reagent products carried by boat or processed in concessionary business (flammable chemicals as xylene and alcohols, and toxic chemicals as methanol and barium chloride).
3. Biologics: products from the processes of the concessionary port business. That may cause the spread of pathogenic micro organisms (microseaweed and cianobacter).

In the other hand, there are also 3 kinds of solids (Cedex, 1994):

1. Dangerous solids: granulated chemical products that may dissolve and bio accumulate (fertilizer products).
2. Potentially dangerous solids: chemical products associated to a lower danger than the previous (agro foodstuffs and coal powder).
3. Not dangerous solids: products from stores and offices not included in the previous categories.

Secondly, the dangerous event is assessed by the disturbance around the contaminant event. It is evaluated in accordance with the expression of dangerousness, represented by three factors: the dangerousness, the affected extension and the susceptibility of the affected water bodies.

The dangerousness (Fp) is measured by the substance spilt registered in the standard form. (Ondiviela, 2006; Ondiviela, 2007).

The degree extension (Fe) evaluates the affected surface (m^2) by liquid contaminant events or the spilt quantity (T) by solid contaminant events. (Autoridad Portuaria de Tarragona, 2004).

The susceptibility (Fs) is calculated according to the conservation level of the affected waters. (Gómez, A.G., 2007).

Taking these factors into consideration, the danger associated to a contaminant event may be not dangerous, dangerous or very dangerous. If the final value is under 6, the contaminant event is not dangerous, if the final value is between 6 and 12, the contaminant event is dangerous, and if the final value is over 6, the contaminant event is very dangerous.

$$Dangerousness = 2 \ x \ Fp + Fe + Fs \qquad (1)$$

The Fp is the hazard posed by the contaminant event to affect the chemical and ecological quality, the human health or the established usage. This factor is valorated from 4 to 1.
The Fe is the affected surface by the contaminant event to liquid events and the quantity spilled to solid events. This factor is valuated from 5 to 1 according to the affected area.
The Fs is the susceptibility of the waters to the contaminant event and is evaluated in agreement with the type of bodies affected by the contaminant event from 5 to 1.

3. Action – Actuation Plan

The action – actuation plan is activated when an event has been detected, confirmed and classified. This plan is a designed mechanism to solve the contaminant event. The objectives of this plan are: to reduce the consequences to the environment, to notify the public services, to coordinate correctly with other plans, to report information to the authorities and to recover the environment.(Autoridad Portuaria de Tarragona, 2004 – 2005; Autoridad Portuaria de Santander, 2003; Generalitat de Catalunya 2003).
In accordance with figure 3, to activate the action – actuation plan depends on the dangerousness classification of contaminant event, esteemed at the previous expression.
An actuation plan related to the substance spill will be implemented with different techniques of retaining, recovering and elimination according to the spilt product. Finally, the progressive removal of the mentioned plans will take place, when the contaminant event has been controlled. (OMI, 1973 - 1990).

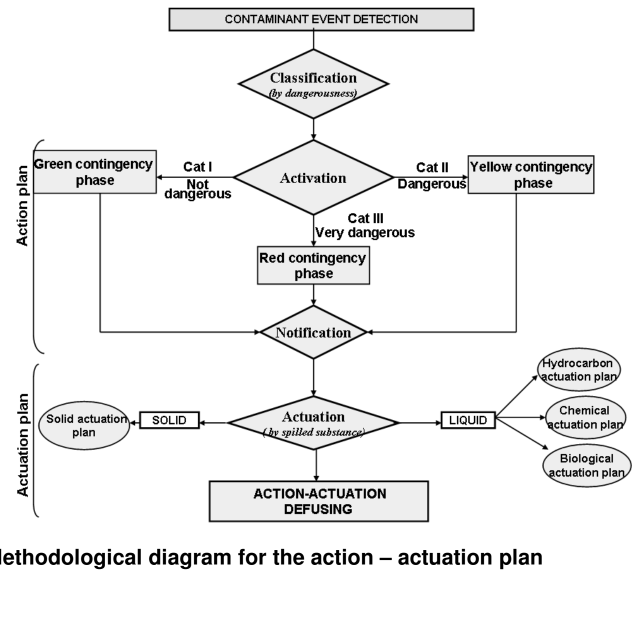

Figura 3. Methodological diagram for the action – actuation plan

4. Recovery Plan

The recovery plan analyzes the recovery process of the affected water body. It is only implemented on dangerous and very dangerous events in accordance with the classification of the contaminant events.
The recovery plan consists of the selection of the suitable indicators, the design of the monitoring plan and the parameters evaluation. This plan is developed according to the systematic monitoring plan designed in ROM 5.1. (GESHA, 1995; Ondiviela, 2007).
The recovery plan involves the selection of the suitable indicators depending on the substance spilt.
The design of the monitoring plan is implemented according with the dangerousness value established on the classification of the contaminant event. This plan is implemented in pelagic environment and sediment benthic environment (Doménech, J.L., 2004).
Finally, the recovery evaluation is based on the Standstill principle in which the water body is recovered when the concentration of the indicator has not increased considerably.

PRACTICAL APPLICATION TO THE PORT OF TARRAGONA

The port of Tarragona is located in the northeast of Spain, at Mediterranean Sea. It has an important industrial activity, specially chemical and petrochemical, and it is one of the most important Spanish harbours in terms of load/unload activity. The port of Tarragona has 512 Ha of land surface where several jetties are located. (GESHA, 2006).

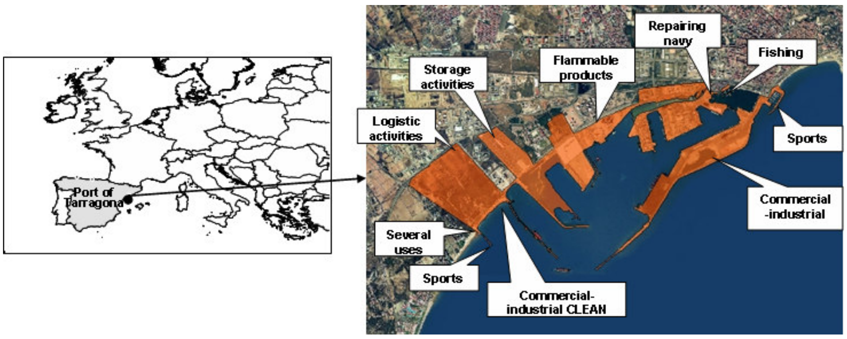

Figure 4. Location of the port (left) and harbour uses at ZSP (right)

The port has an unload buoy, belonging to Repsol YPF, which allows the unload operations in the sea. This point has contaminant events associated with this dangerous activity because this buoy is linked by a pipe to Repsol jetty. The most important unload operations are related with hydrocarbons that could affect significantly the water bodies.

At October 21th, 2007 the port suffered a contaminant event all along the hydrocarbon unload in this structure. This contaminant event was solved with the application of different contingency plans.

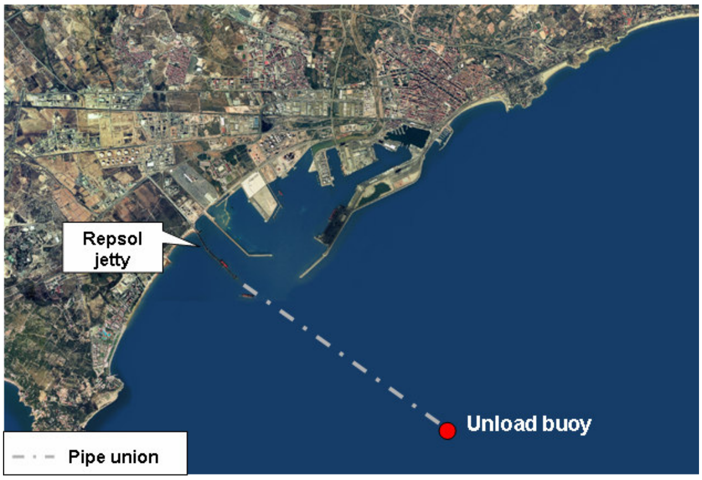

Figure 4. Location of the unload buoy

The applied methodology to this contaminant event will be explained next. Firstly, it should been established a visual inspection plan with a colour map of inspection related to the activities in each zone. The green level covers the recreative areas. The yellow level covers the beaches, the leisure port, the fisherman area and the storage area. The red level covers the inside basin with industrial activities. The standard form would have filled in, a classification of the contaminant event it should be made. The contaminant event spilled is hydrocarbon and it was very dangerous according to the dangerousness expression.

Dangerousness: $2 * Fp + Fe + Fs = 20$ (2)

Fp = dangerousness = 5 because the spilt product is a hydrocarbon
Fe = extension = 5 because the affected area is more than 1000 m^2
Fs = susceptibility = 5 because it is affected a bath zone

Then, the red contingency stage of action plan should have been activated, as well as the hydrocarbon actuation plan.
Finally, as part of the tasks of the recovery the indicators associated with the contaminant events should be selected. For this reason, the parameters sampled should have been total hydrocarbons in water column and PCB's and HAP's at

benthic environment. Finally, the monitoring plan should have take place every week for four weeks, until the water body were recovered.

CONCLUSIONS

Firstly, the visual inspection plan is a basic tool in contaminant events detection because it establishes the origin of the event and a rapid detection. At visual inspection plan, the record of the information in a standard form is very important to go on with the process.

Secondly, the classification of the contaminant events by the spilt product and the dangerous helps to establish the action - actuation plan and the recovery plan.

Thirdly, the development of an action – actuation plan is important to solve the contaminant event. It is necessary to study new techniques to solve the contaminant events taking into account parameters like granulate side.

Finally, the recovery plan is very important in dangerous and very dangerous events. It is necessary to study others suitable measure parameters and also it is necessary other forms of recovery evaluation, since the comparison with an absolute value, can be wrong because of weather or littoral conditions.

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