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Role of the Spanish scientific community in the initial assessment and management of the environmental damages caused by the *Prestige* oil spill

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Abstract

The role of the Spanish scientific community in the initial assessment of the environmental and socioeconomic damages caused by the *Prestige* oil spill is analysed. A discussion of the reasons for the failures in the response of the scientific community is presented, highlighting that despite the existence of adequate human capital and infrastructures, failures were related to the weakness of the structures and organisational capacity of the scientific institutions and the public administration. Some developments for an effective response to future catastrophes are proposed: (1) oceanographic and ecological models, including scientific and local knowledge; (2) management systems for scientific information; (3) organisational and incentive systems to allow the creation of temporary, large and well-organised multidisciplinary teams; (4) protocols for rapid, ''real-time'', damage assessments; and (5) participation of different social groups (NGOs, fishers' organisations, aquaculture industry or volunteer groups) in plans for the assessment and management of crises.

Keywords: Oil spills; Scientific response; Crisis management; Damage assessment; Marine ecosystems

1. Introduction

The oil tanker *Prestige*, loaded with a cargo of 77,000 mt of heavy bunker oil ran into problems off the Galician coast (an autonomous region in the NW Spain) on November 13, 2003. After a 6-day odyssey following an erratic course, it finally sank 130 miles west off the southern coast of Galicia [1,2]. Over the course of these 6 days, about 19,000 of oil were spilled, and in the following months around 40,000 mt of fuel leaked into the sea with large slicks drifting towards the Galician coast. The oil spill reached first the Atlantic shores of Galicia and later the Spanish Cantabrian and the French Atlantic shorelines up to Brittany, and to a lesser extent, the north coast of Portugal. This oil spill may be considered as one of the worst in history, both in terms of the type and volume of hydrocarbons spilled as well as the extent of the disaster, affecting the coastline, subtidal and continental shelf bottoms [3,4].

Moreover, the disaster caused by the *Prestige* triggered a social crisis leading to a movement of mass protest [5,6]. In this sense, the socio-political climate during the first few weeks and months after the beginning of the oil spill created conditions that were not at all conducive to scientific work, and at the same time they highlighted the limitations imposed by the organisation of the Spanish and Galician scientific community when faced with responding to problems of this nature.

The ecological impacts of an oil spill (and its socio-economic consequences) depend upon multiple, difficult to predict, factors which give rise, in cases such as this, to opposing initial assessments owing to speculations

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based on partial information and/or socio-political interests that are more or less legitimate (ranging from standpoints given with caution so as not to cause unnecessary alarm, to intentionally concealing information to protect the interests of a specific political action or economic sector). Social concern also tends to diminish exponentially over time, while obtaining objective information is only possible in the medium and long term.

The present paper analyses different topics related to the role of scientists and the Galician and Spanish scientific communities in the initial (mainly in 2002 and 2003) assessment of the environmental and socioeconomic damages caused by the *Prestige* oil spill and the recovery of the ecosystems affected. A discussion of the reasons for the failures in the response of the scientific community is presented, with an analysis of two key aspects: the availability of human capital and infrastructures, as well as the structures and organisational ability of the scientific institutions and the public administration. Lastly, we will use the experience acquired in this catastrophe to draw up some proposals for improvement that might be able to increase the efficiency of future scientific actions in the event of the occurrence of natural catastrophes.

We do not intend to judge the management of this crisis or its socio-political consequences. We must remember, however, that the scientific activity was often the focal point of public debate and political confrontations and that the response of the scientists was conditioned by this socio-political context. Probably, this situation created the worst possible scenario to carry out scientific work.

2. Organisational structure of the scientific community

In order to understand the (or the lack of) scientific response, first of all we must briefly review the organisational structure of the scientific community in Spain, both in the area of marine sciences (those in charge of assessing the environmental and ecological impact, and of carry out bioremediation and ecosystem restoration actions), as well as in the social sciences (which focus on the study of the socio-economic impact and actions to recover the affected human communities). We will focus our analysis on the marine sciences, a field that presents a wider ranging institutional diversity and played a more important role in the initial stages of the crisis. The social scientists potentially related to the response to the *Prestige* oil spill work mainly at the universities, and the reflections made for the case of the marine sciences at universities are largely applicable to them.

Marine scientists who would be potentially involved in an oil spill in Galicia of this kind generally belong to three types of institutions, although their fields of expertise may not pertain to this division. The Autonomous Government of Galicia (*Xunta de Galicia*, XUGA) has centres and specialists in the marine environment and fisheries covering coastal or inshore waters where artisanal fisheries operate [7]. The Spanish Government through the Ministry of Science and Technology (*Ministerio de Ciencia y Tecnología*, MCyT; replaced after mid-2004 by the Ministry of Education and Science), has set-up different research centres specialised in marine sciences, such as the centres dependent on the Higher Council of Scientific Research (*Consejo Superior de Investigaciones Cientificas*, CSIC): the *Instituto de Investigacións Mariñas* established in Vigo (south Galicia) and other centres along the Spanish Mediterranean coast, and the *Instituto Español de Oceanografía* (IEO) with two coastal centres (in A Coruña, North Galicia and Vigo). The fundamental task of the IEO is the assessment of fishery resources, particularly those managed by the Spanish Government (through the General Secretariat of Maritime Fisheries of the Ministry of Agriculture, Fisheries and Food) that is in charge of the resources from the "offshore" continental shelf (semi-industrial fisheries, mainly trawlers, purse-seiners and longliners) and distant-water industrial fisheries. In addition, the IEO has research groups specialised on the marine environment, and therefore, not focused exclusively on fisheries. The CSIC, on the other hand, is an institution that conducts a more academic-oriented type of research, offering more freedom and diversity in terms of research topics pursued by their scientists.

The public universities in Galicia (A Coruña, Santiago de Compostela and Vigo) and in other parts of Spain boast a number of research groups in the field of marine sciences. In fact Galicia has the largest concentration of this type of scientists in all of Spain. It could be assumed that research done in the framework of the Spanish university is virtually independent of the guidelines of its managing bodies (at the level of the university or autonomous government on which it depends economically and legally, despite the autonomy of the university), and it generally hinges upon small groups (or individual researchers) often with little inter-connection. This university model corresponds, at least in part, to a model of incentives that has been set-up to promote scientific activity, based on individual productivity (measured mainly by papers published in scientific journals of recognised international reputation) which tends to lead to a quest for highly productive lines of research that do not require large infrastructures (fundamental in a great deal of marine research, but in most of the cases unavailable at Spanish Universities), with occasional collaborations between individual scientists and/or small groups. This model works reasonably well in normal situations, as is evidenced by the rise in

scientific productivity at the universities in recent years [8].

To fully understand the university model, we must consider a second factor related to the measures implemented by different public administrations (especially the XUGA, and recently, although to a lesser extent, the European Union), to create research groups with a minimum critical mass that will allow for the optimisation of the resources. The design of these measures generate hierarchal structures, in which the scientists come together out of legal needs, creating dependencies that do not always correspond to scientific activity (which for the most part continues to be conducted on an individual basis or in small groups with little cooperation and coordination). Moreover, interdisciplinary activity is not encouraged, rather it is hindered, owing both to formal difficulties as well as to the lack of consideration given to this type of research.

Furthermore, as was demonstrated by the catastrophe of the *Prestige*, the universities are not endowed with adequate managerial and organisational structures capable of offering urgent responses to meet the needs of a multidisciplinary and coordinated scientific action in the face of situations of crisis. At the same time, the mentality and objectives of the university scientists generally tend to restrict this process, as it is difficult to establish common objectives acceptable for the researchers and mechanisms to coordinate their work. The public administrations have little or no capacity to demand that the scientists come up with immediate responses to situations of crisis and, in the case of the *Prestige* oil spill at least, they may show little interest, in view of the difficulties involved in controlling the information that would be generated. The public administration, naturally, has an essential instrument to involve the scientists of interest to them, as they control the great majority of funds earmarked for the research and monitoring of the marine environment. Even so, the organisational structure of the universities may greatly hinder the organisation of rapid, interdisciplinary responses to specific problems.

Research centres depending on both the XUGA and the IEO are potentially equipped with the ability to respond rapidly to critical situations since they can immediately change the work plans of their scientists and define specific objectives depending on their socio-economic and political interests (inclusive although they may contradict scientific criteria). The case of the CSIC may be considered as a *de facto* intermediate situation between the above cases and that of the universities, having many different aspects in common with the latter.

A new situation, still in the early stages, which was observed in the case of the *Prestige*, is the appearance of other organisations more or less independent from the public administration, which have a certain capacity to respond to these problems or may be able to fund research and assessment carried out by independent scientists (either from the private sector or from the universities and the CSIC) [6]. This is exemplified by the different NGOs, belonging primarily to the environmentalism, and the fishers' associations, the great majority of which have organised into the Commission of Fishers' Organizations (*Cofradías de Pescadores*) affected by the *Prestige* oil spill, which have carried out these types of activities.

3. The scientific response of the Spanish and Galician Governments

We will not present a detailed analysis here of the chronology of actions and their characteristics and objectives, but it is clear that in the early days of the crisis, there was a high degree of disorganisation and a lack of response to immediate needs [1,5,9]. Later, both the autonomous and central governments, through their research centres (and each one almost always acting in a totally independent way) started a series of activities geared towards the impact assessment and the monitoring of the evolution of the oil spill, and to monitor pollution in order to assure food security as well as to protect the marine environment in general. During this second stage, the studies were designed mostly without consulting the university scientific community, where a great deal of the scientific experience in marine science is concentrated, and without consulting most of the groups working within the public administration.

The Galician Ministry of Fisheries and Maritime Affairs (Consellería de Pesca e Asuntos Marítimos) tackled the bulk of the problem right from the beginning, both in terms of informing the public as well as assessment and research [1,6]. Its actions appear to have been totally autonomous and isolated from the rest of the scientific community and even today detailed information about the studies conducted, their objectives and results has been not made public, except for the part that deals with food safety, which has been directed at re-opening fishing zones after precautionary closures [10].

The IEO started in December 2002 a series of studies focusing on the Galician and Cantabrian continental shelf ecosystem and its fishery resources [11], making use of its own infrastructures and human resources. Most of the results were made public right away and are consistent with the existing scientific knowledge on oil spills. However, the coastal zone was probably the most affected habitat by the *Prestige* spill, and the effects on the shelf were of lower intensity [4,12], which means that the usefulness of the data provided by the IEO may be limited for a comprehensive evaluation of damages. In fact, the IEO has continued and even stepped up its

routine scientific actions focused in the assessment of fishery resources. From the standpoint of optimising the use of the limited existing resources, the priority given to increasing studies on the continental shelf is debatable when the coastal area has suffered graver damage and studies on the latter have been limited due to restrictions of human, material and financial resources. This highlights another limitation of the scientific organisation, which does not allow to take advantage of all the resources of an institution like the IEO, to be able to respond to a problem that is out of the scope of its work plan (for legal and administrative reasons, most than for scientific motives).

In December 2002, the MCyT, through the CSIC, began to draw up a medium-term plan of action which included, oddly, almost exclusively the participation of scientists from Mediterranean centres. It was not until the end of the process, probably owing to public and private criticism, that they started to admit contributions from other institutions and centres as well as from universities in Galicia and the rest of the country. Inexplicably, most of the work devoted to the design of a plan of action, has not been published. The response of the CSIC has fluctuated widely over time, with a deluge of reports and the apparent start of studies a few months after the disaster (at the height of public demand for scientific investigations), which later appear to have slowed down or even disappeared, at least as far as public dissemination is concerned (this fact is evident checking the reports published on their website and the dates) [13].

The role played by the IEO and the CSIC appears to reveal an institutional interest in leading the scientific response and controlling the resources that might be mobilised to this end as well as internal struggles within and between these institutions coveting this role.

4. Scientific and social response of the university

The response of the university has been almost absent at the institutional level (except in the case of some scarcely effective statements) and it has turned into the response of individuals or small groups, who have organised themselves in view of the lack of action and errors made by the public administration. At the Galician Universities, there has been a clamour for an organisation that would allow for the creation, on a temporary basis, of multidisciplinary groups to handle the scientific assessment of the crisis and respond to social demand. However, the management teams have been unsuccessful in meeting this demand, owing possibly to the fact that there is no a previous design or adequate resources available for this purpose. Different research groups have conducted studies, most of them still underway and not yet published, which deal with specific aspects of the oil spill, but they have been designed based on the fields of expertise and interests of the participating scientists and therefore, it is highly unlikely that a complete assessment of the problem can be obtained.

Moreover, public statements made by the university scientists, both individually and as a group, have generally been extremely critical of the decisions and management of the public administration, denouncing its assessment of the problem, its lack of action or the incorrect response and the withholding of information, which has led to a situation of conflict [1,6]. Although, a number of different university groups have actively collaborated with the administration, which has generally had little public impact, because of both the administration information policy and the discretion with which these university groups have confronted this subject, possibly as a consequence of the existing social climate.

We will highlight here two examples of communication actions that have sprung up in the heart of the universities—and other institutions—which constitute responses to the attitude and to what has been interpreted as errors made by the public administration. Some professors from the University of Vigo set-up a website [14] on November 21, 2002 "for the purpose of collecting, in a rigorous and objective way, technical and scientific information on the *Prestige* oil spill", in view of the lack of official information. This website rapidly became a reference point from which to follow the evolution of the oil spill through the contributions of different scientists and the synthesis of information and monitoring data provided by French, Portuguese and Spanish institutions. This website was later "institutionalised" by the University of Vigo itself, curiously, when the need for it and its relevance had declined. Moreover, 422 Spanish marine scientists from all types of institutions published a letter in the journal *Science* [9] in which they presented an analysis of the clear scientific evidences advising against towing the vessel out to sea and which would allow predicting easily the trajectory of the oil spill. This letter has aroused a great amount of controversy in the media as well as on a political level, since it denounced a specific incident and was endorsed by numerous professionals.

As far as the coastal zone is concerned (both terrestrial and marine), the vast majority of scientific knowledge is rooted in the universities. And from this standpoint, they undoubtedly offer the basic intellectual capital needed to analyse the impact and the recovery of the coastal system, which was the most affected by the disaster. The university has the necessary knowledge and appropriate human resources, but it does not have the tools needed to use this capital effectively in responding to a crisis of this sort. In the Spanish university model, it is not possible to obtain this response by making a

demand on its members using a command-and-control approach, and this is quite probably one of its greatest virtues as a foundation on which to build scientific creativity and innovation. Therefore alternative methods should be found based on positive incentives. Basically, these incentives would entail the contribution of human, material and organisational resources that are new and different from the usual ones and they must be specific to these cases. Secondly, there would have to be professional incentives—economic or otherwise. We must realise that for most scientists, an oil spill is not an attractive subject for investigation, even from a psychological point of view, but especially because it requires a rapid and intense learning (owing to its very nature, this research cannot be programmed except in very specific aspects), and the expectations of scientific productivity are lower than for the typical research lines. The great challenge yet to be tackled by the university focuses on combining scientific freedom with organisational models that are appropriate for situations of crisis. This scientific freedom, which is hugely profitable under normal conditions and allows for the creation of human capital with diverse interests and knowledge (essential in situations of crisis), must be supplemented with mechanisms for the creation of interdisciplinary groups of response and incentives to obtain the participation of its scientists.

As a consequence of the above, in addition to being slow, partial (in terms of objectives) and ineffective in allocating resources, the scientific response did not make use of the existing capital. Thus, a great deal of the activities did not stem from an objective analysis of the available information, which would allow for the development of hypotheses that would serve to direct the scientific actions. The slow response created an initial gap in the information obtained on the impact, which is essential for appropriate assessment. In the case of the *Exxon Valdez*, for example, the NOAA set-up groups whose purpose was to evaluate the status the coastline prior to the arrival of the oil spill using oceanographic information that made it possible to predict the evolution of the oil spill [15]. A good example is the monitoring of the assessment of the *Prestige* oil spill in offshore waters, which is crucial to the coordination of activities to combat pollution. The Portuguese Hydrographic Institute provided detailed, up-to-date information over the Internet from the very start [16], which, day by day, proved to be an accurate account of the situation. The Spanish Administration, in contrast, did not manage to set up a similar monitoring program until after the bulk of the oil spill had already reached the coast [12]. Information on the chemical composition of the fuel (and consequently its potential toxicity) was published from the very first days by the French *Centre de Documentation, de Recherche et d'Expérimentations sur les Pollutions Accidentelles des Eaux* (CEDRE) [17], whereas it took the Spanish and Galician Administration several weeks to provide this information, and moreover, initially with different results from those reported by the French institution (and with a higher degree of ambiguity, especially in relation to the presence of toxic compounds). Subsequent analyses confirmed the veracity of the French data, raising doubts about the initial information provided by the Xunta de Galicia, which did not report traces of polycyclic aromatic hydrocarbons (PAHs) of high molecular weight in the fuel spilled by the *Prestige*.

5. Publicly funded research actions

All of the above scientific initiatives materialised in a limited number of actions funded by the public administration, which started these activities after a considerable delay, very likely jeopardising the procurement of critical initial data on the environmental impact.

The Autonomous Government of Galicia has limited itself to including the disaster caused by the *Prestige* on the list of priority lines of its programs to finance research projects, but it has not earmarked additional funds to resolve these issues or, in any case, this aspect has not been made public.

In December 2002, the Spanish Government set-up a Scientific Advisory Committee which completed its studies in February 2003. This committee focused on providing solutions to the problem of the recovery of the oil remaining in the sunk vessel and took little account of the environmental impact question. In addition to this initiative, the MCyT is the only public institution that has summoned public participation with specific financing. The management of these actions has been long-drawn-out and controversial (as discussed earlier) but it has led to the creation of a Technical Office of Marine Spills (*Oficina Técnica de Coordinación del Programa de Intervención Científica para la Acción Estratégica contra Vertidos Marinos Accidentales*) [18], with the participation of the Universities of Galicia and Cantabrian regions, the IEO, CSIC and MCyT, in charge of the management of two types of research and assessment actions. Initially, between February and April 2003, a series of Special Actions received funding to cover especially urgent problems. These projects were not open to public proposals and were negotiated with research teams that could take on these tasks immediately. These Actions were planned for a period of 6 months (from May to November, 2003), and in general consortiums of research groups have been set up to resolve specific questions such as inter-calibration among the laboratories in charge of the PAH analyses, the initial impact on biological communities on coastal and continental shelf ecosystems as well as the

geophysical characteristics of the zone where the ship sank, to name but a few.

In addition, in March 2003, the MCyT called for a three year strategic action on accidental marine spills to finance projects lasting three years. This follows the general system of open calls with priority lines and, in some cases, constitutes the continuation of the urgent actions discussed earlier.

To offer an approximate idea of the funding effort made by the public administration, we must bear in mind that both actions of the MCyT are funded in an amount that probably does not exceed 10 million €, according to several different unofficial sources. In the Exxon *Valdez* oil spill, the expenses earmarked for damage assessment amounted to US$ 214 million, while an investment of around US$ 180 million was made for research and monitoring [19].

6. Recommendations for coordinating the scientific response and designing a contingency plan

The analysis conducted in the present paper has made it possible to draw a number of conclusions regarding the weak points of the Spanish public scientific system. We will conclude by raising some basic ideas that might help to improve the response of the scientific community when faced with future environmental crises and to optimise the use of available human and material resources:

- It is necessary to develop a priori oceanographic and ecological models and hypotheses that will allow predicting the evolution of the spill and its environmental and ecological consequences. These models and hypotheses must be based on the available knowledge on the potentially affected ecosystems and on the physical and chemical characteristics of the oil spill. For example, it is important to create oceanographic models that can predict the transport of hydrocarbons in terms of the geographical location where the spill occurred and the climate and oceanographic conditions of the zone, or foodweb models of the ecosystems affected in order to predict the transfer routes and the bioaccumulation of pollutants. These models and hypotheses will allow designing research and assessment activities in real time, directing the available resources to the problems that are objectively identified to be more pressing. Given the current limited scientific knowledge, the development of these models will require a combination of predictive science and the local knowledge of the scientists themselves and other social actors that have interests and experience in these ecosystems, such as, for example the fishers or NGOs.
- Knowledge management systems are needed to work with the available information on the natural resources and ecosystems in the areas of interest. At the present time, the available information on these aspects is qualitatively and quantitatively important and potentially very useful. However its lack of systematisation makes it difficult to access quickly. In this sense, there are no initiatives for the creation and maintenance of open-access databases on ecosystems and marine resources, in fact there is not even any open-access digital cartography available. These are essential tools needed to aid managers and research groups who must make rapid and well-informed decisions in situations of crisis.
- The design of organisational and incentive systems to allow the creation of temporary, large and well-organised multidisciplinary teams. These groups should be put together immediately after the crisis starts and to have available the necessary resources to carry out their work. It is essential for these groups to collaborate actively with the local communities in all the stages of the work.
- The damage assessments requires initial evaluations done "in real time", including the collection of prior information in the areas affected, anticipating the arrival of the oil spill by predicting its transport on the basis of climate and oceanographic conditions. In order to fulfil this objective, in addition to other considerations, it is necessary to have protocols included in the contingency plans that will be able to offer an immediate response.
- In addition to the urgent scientific actions, it is crucial to develop research programs in the medium and long term, given that many of the effects can only be detected on these time scales. To meet this objective, there are two basic alternatives: the "normal" system of funding calls (completely open and loosely directed towards specific objectives) or the design of "closed" or "directed" plans which target the specific topics to be studied and the most appropriate research teams to carry them out. There is, of course, a wide range of intermediate solutions that may be more or less valid depending on the existing scientific knowledge and the diversity of scientific fields of study. In any case, a clear scientific policy that will allow to choose the most appropriate option considering the existing scientific context is needed.
- The design of public plans for the assessment and management of crises of this type should consider the participation of different social groups such as NGOs, fishers' organisations, the aquaculture industry or volunteer groups. This participation is needed to design the programs for damage assessment and the restoration of the affected ecosystems, for the logistical collaboration in the development of the tasks, to share knowledge and procure financing. At the same time, we must not forget that a crisis of this

type, and the *Prestige* oil spill is a clear case, entails the contribution of donations by many social actors who may play key roles in obtaining funding for these types of actions.

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