The economic analysis of maritime catastrophes in sensitive areas: the assessment and calculation of damages in the environment and population’s way of life

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ABSTRACT

Maritime transport is not only one of the safest ways to move dangerous freight it is also one of the most profitable from the economic point of view. Despite this, accidents are inevitable and sometimes become catastrophes. There are some geographical locations where these accidents or disasters are repeated frequently and then can be considered “black spots”, this is the case in the northwest of Spain: Galicia, where maritime disasters are frequent. The last one, starring the Prestige has involved extensive damage from the environmental point of view and has endangered environment sustainability and even the population style of life. This study is evaluating the effects of disaster and the resilience of the environment and the population. The maritime disasters, repeated over time, attack the local way of life from the point of view of the economic and environmental aspects, and also generate feelings of helplessness and lack of confidence in the institutions responsible for general environmental safety and particularly for sea. The findings indicate that it is necessary to create institutional mechanisms preventive by means of clearly specified rules and controls, together with the identification of agencies responsible for development and execution of proposals, able to generate confidence in the local population and respond appropriately to prevent potential disasters.

1. Introduction

Globalization has encouraged the growing integration of the different economic areas, the development of the international trade; the best transport infrastructures make flows of goods and services easier. Maritime transport is part of the economic globalization process, especially when it comes to carrying commodities as hydrocarbons and dangerous products. The increase of maritime traffic of dangerous goods has shown the most risky exposed navigation areas, but some of them are in what it could be called “vulnerability”, understood as the relative tendency a system has to suffer accidents that could generate significant transformations, either structural or permanent, and deep changes, not only from an environmental point of view, but also from the style of life of the resident population.

There have been lots of papers analyzing environmental aspects for maritime catastrophes, but only a few of them deal with the changes on lives of the people involved, directly or indirectly, in these catastrophes. Galicia is a Region located in Spain, North West region, and, unfortunately, known abroad due the periodical accidents occurred on its coast. It is not by accident that the Fisterra (The End of the land) code is in the “Costa da Morte” District (Coast of the Dead), one of the most beautiful places, with plenty of environmental treasures, in Galicia. The last bulk ship accident in this coast was the Prestige, which was classified as one of the most important catastrophes in the world. Nevertheless, Maritime Transport is not only one of the safest ways to move dangerous freight, but also one of the most profitable from an economic point of view. Despite this, accidents are unavoidable and sometimes become catastrophes. There are some geographical locations where these accidents or disasters occur frequently and that can be considered “black spots”, this is the case in the northwest of Spain: Galicia, where maritime disasters are frequent. The last one,
starring the Prestige, in 2002, has involved extensive damage from an environmental point of view and has endangered environment sustainability and even population's lifestyle.

In the last decades, the studies related to marine conservation moved their focus to the complexity of coupled environmental—human systems (Bigagli, 2015). Maritime systems can be thought of as comprising the interaction of two subsystems: the biophysical and the human (Perry et al., 2010). Literature shows the close link between marine ecological and human systems, as interactive, with such interdependence that creates feedback loops, whose effects are difficult to predict and measure (Bigagli, 2015; Hughes et al., 2005; Perry et al., 2010). The socio-ecological marine systems, should be concerned, from regional and local responses, about socio-economic development, economic bases, demographic and cultural features, among others (Perry et al., 2010).

Two aspects are main focuses for this paper: the analysis of the effects of Prestige's disaster on normal lives of population, towards normative environmental and institutional actuations to prevent and avoid the maritime contamination due to catastrophes, and the analysis of the economic activity of Galicia and its relation with population's way of live, because, maritime security is closely related to economic development (Bueger, 2015). In this paper the effects of the Prestige disaster are analyzed, from the point of view of people's feelings and way of life of the population. For example, the normative framework changes are, for sure, a clear consequence of the Prestige's disaster. It has paid particular attention to fishing and tourism, as a way of earning their living, but also to demographic issues, people feelings and other related questions that are also taken into account, because all of them are the ones that draw the population's lifestyle, day by day. For achieving our goal, there have been used researches made by the Galician Statistics Institute, at Municipality level, that is the lowest that this Institute supplies. The chronological time is the one that goes from the date of the disaster (November 2002) to nowadays. The possible differences between the municipalities are analyzed, from the point of view of the level of affectation of the fuel spilled.

2. Maritime catastrophes and regions affected: maritime disaster in Galicia: the Prestige and resilience of population and environment

On Wednesday, November 13, 2002, an oil tanker 26, sent an SOS 50 miles from Finisterre (Galicia-North West Spain). It was the beginning of the greatest ecological disaster in the history for Galicia. The coup opened a leak in starboard of two empty tanks and brought a heeling 25°. An hour later, 24 crew members were evacuated by two helicopters, Captain Maguras, the first officer and the chief engineer remained on board. At Five O’Clock in the Afternoon the oil tanker begins to expel its cargo of fuel oil M-100, PHN one of the most toxic petroleum derivatives.

The Prestige, single hull oil tanker, was built in Japan in 1976, Greek registration and sailing under the flag of Bahamas. It was vetoed by the Spanish association of petroleum product. In 1999 it had been sanctioned in New York and Rotterdam by two security flaws. The vessel avoided entering the ports of the European Union. It had left Riga (Latvia), bound for Singapore, after a stopover at Gibraltar. It was loaded with 77,000 tons of fuel oil, valued at 60 million euros. At the end of Wednesday, the ship had lost about 6000 tons of fuel. The stain was 6.2137 mi (10 km) long and 0.18641 mi (300 m) wide. The Spanish government decided to move the vessel away from the coast, and informed that everything was under control. The storm continued, the ship was shifted (see Fig. 1) initially to the north and then west. The hull breach was becoming increasing. On Saturday November 16th the oil spill reached the shore and polluted 118.06 mi (190 km) of coastline. At 8:50 am on Tuesday November 19, 2002, the Prestige sank down, 161.56 mi (260 km) of Galician coast, and a depth of 11,483 ft (3,500 mt) in abyssal waters. There, the temperature was 36.140 °F (2.3 °C), which made hope for the 66,000 tons of fuel that remained inside the boat could get solidification, but it didn’t.

In Galicia the citizen movement “Nunca Más” (Never Again) emerged and, outside Spain, harsh words were heard: Chirac (the President of French Republic) spoke of “incapacity” of the European Union to avoid maritime disasters and declared that he was “appalled” by the oil slick splashing Galicia. The New York Times wrote that the Galician disaster could be greater than that caused the Exxon Valdez in Alaska in 1989. In England, The Guardian asked “Do you have a sticky problem?: Do not worry, you can pour it off the African coast”. Although there was no anti-pollution vessel in Spain, the government rejected offers of assistance from Germany, Italy and Britain. However, civil society was mobilized, to alleviate the disaster: the “white tide” appeared (La Voz de Galicia, 2002). In the past 30 years, Galicia, the region most dependent on the sea of the European Union, has suffered seven of the eleven major water disasters in Europe. Some 300,000 oil Tones have degraded the Galician coast in recent decades. The Prestige, affected more than 500 km of coastline, including both, French and Portuguese coasts.

2.1. Could the history of the Prestige be repeated? What have we learnt from the past?

Industrial development and growth of trade, has boosted the oil companies to get rid of their fleets and then, some independent smallholders have arisen and they have flagged their vessels in open registry countries. At the same time, developed countries have provided the so-called “second registers” (with minor requirements) of their fleets in order to achieve for a significant number of their vessels. The quality and age of the vessels carrying dangerous goods or capable of causing marine pollution were not the main concern of states neither of international organizations. There were not enough controls, nor an international legislation assumed by all countries in order to establish prevention criteria for that type of traffic. The international institutional framework was not able to design regulatory systems to avoid, alleviate and mitigate the negative impacts of risks. It was from the Erika accident (December, 1999) when the Spanish and EU regulations began to develop measures to anticipate, prevent and reduce negative impacts. In other words, the EU reacts only after disasters. The policy packages (Erika I: March 21, 2000); Erika II (December 6, 2000) and Erika III, (November 23, 2005) were including new sections in the light of the demands of civil society and people affected as a result of accidents. Then there is a tendency to mitigate, but not eliminate “bad practices” still prevailing. In times of scarcity of accidents, there is not developed a new legislation. However, international conventions (Civil Liability Convention, approved on 1992 and IOPC Funds, approved on 1992) on financial compensation are very limited: the amounts are not sufficient, do not include some of the negative impacts, prompt compensations are not assured, they usually generate strong disputes between administrations and those affected. And they only act after another new accident. A summary of the maritime regulations and its origin related to maritime disasters is on Table 1.

Galicia experienced a total of 7 accidents on its shores since 1970: 1970, Erkowitz (pesticides); 1970 Policommander (petroleum); 1976 Urquiola (petroleum); 1978, Andros Patria (petroleum); 1987, Casson (chemicals); 1992 Aegean Sea (petroleum); 2002 Prestige (fuel). It is the European region with the highest number of accidents. In proximity to an area of sea passage (runner Finisterre) and the European region with the highest level of fishing
Table 1
History of maritime regulations in light of the respective accident.

<table>
<thead>
<tr>
<th>Accident</th>
<th>Characteristics</th>
<th>Momentum</th>
</tr>
</thead>
<tbody>
<tr>
<td>TITANIC. April 1912, Newfoundland</td>
<td>Around 1500 dead</td>
<td>It brought the London Meeting (1914) by which organizes the 1st International Conference on Safety of life at sea. It is the origin of international rules on safety of navigation (lifeboats, permanently open radio, etc.)</td>
</tr>
<tr>
<td>TORREY CANON. March, 1967 Cornouaille</td>
<td>Pollution 250 Km. In the British coast and 100 km. Off the French coast</td>
<td>The Legal Committee in the IMO (International Maritime Organization) and the 1969 Convention relating to Intervention on the High Seas and compensation for damage caused by oil transport, the creation of FDAC (1971) and the signing of the Convention is adopted MARPOL (1973) on the prevention of oil pollution. American pressure. The International Conference on Security of tanker ships (held in London, 1978) is called, and major changes in the technical regulations are adopted, these measures include duplication of dashboards, inert gas system to prevent explosions, etc.</td>
</tr>
<tr>
<td>ARGO MERCHANT. December, 1976 EEUU</td>
<td>About 15 maritime accidents in USA cause pollution on the beaches in Massachusetts</td>
<td>American pressure. The International Conference on Security of tanker ships (held in London, 1978) is called, and major changes in the technical regulations are adopted, these measures include duplication of dashboards, inert gas system to prevent explosions, etc.</td>
</tr>
<tr>
<td>AMOCO CADIZ. March, 1978. TANIO. March 1990. French coast</td>
<td>Large oil slick</td>
<td>Insufficient management with regard to safety is evident. IMO decides to arbitrate international standards for safety management.</td>
</tr>
<tr>
<td>HERALD OF FREE ENTERPRISE. March, 1987 Zeerburg</td>
<td>193 people dead</td>
<td>Open the door to the ISM code on safety management.</td>
</tr>
<tr>
<td>SCANDINAVIAN STAR. April, 1990. North Sea</td>
<td>Catastrophe in the passenger transport</td>
<td>Gran legislative movement. The Oil Pollution Act (1990) is adopted in the USA. The IMO (1992) amended the MARPOL rules on double hull tankers and adopted more stringent and numerous inspection programs.</td>
</tr>
<tr>
<td>EXXON VALDEZ. March, 1989. Alaska</td>
<td>Large oil slick</td>
<td>The European Commission proposes a common maritime safety policy and began the provisions on the classification societies, crew training and control by the port State, among others.</td>
</tr>
<tr>
<td>HAVEN April, 1991 AEGEN SEA December, 1992 BRAER January 1993 European Coast</td>
<td>Oil slicks</td>
<td>The European Commission proposes the Erika I and II packages, in order to ensure better implementation of safety standards and increased compensation schemes of oil slicks. IMO also adopted a series of measures to strengthen the safety of maritime transport of oil. The Erika III drove the increased responsibility of flag States vessels; reinforcing the process of inspection and certification of Classification Societies; a legal framework on places of refuge is accurate and promoted the creation of the European Maritime Safety Agency.</td>
</tr>
<tr>
<td>ESTONIA September, 1994 Baltic Sea</td>
<td>850 people dead</td>
<td>Acceleration of the ban on single-hull tankers and begins the use of double-hulled ships. Increased monitoring of shipping lanes.</td>
</tr>
<tr>
<td>ERIKA December, 1999 France</td>
<td>Wide impact disaster</td>
<td></td>
</tr>
<tr>
<td>PRESTIGE November, 2002 Galicia</td>
<td>Global catastrophe of enormous impacts</td>
<td></td>
</tr>
</tbody>
</table>

Source: authors’ own.
employment in Europe. In the case of the Prestige, institutional responses in Spain were focused on making a “quick action to address a compensation for the effects of the situation originated for being unable to work”. But later, the Contingency Plan was not revised, nor the mechanisms of decision-making or immediate intervention. There was no counselor, Scientific and Technical Council to assist in decision-making. Those compensation’s systems have not been amended yet. By contrast, civil society reacted very positively: increasing awareness, active participation, and strengthening of the degrees of concern. So, population feelings were growing in lack of confidence on institutions and confidence on civil institutions, in this situation, latent behavior of population being affected.

2.2. Resilience of environment and population

When a disruption occurs in the MTS (Maritime Transport System), the system needs to recover to the pre-disruption throughput level (Oztanriseven et al., 2014). This procedure is designated as the resiliency of a system. Then, resilience involves the ability to bounce back, and quickly continue accomplishing its task after happen the disruptions (Omer et al., 2014). Generally, resiliency has two dimensions, vulnerability and adaptive capacity. Both, territory and population should be willing and prepared to face these situations, being able to manage and minimize the impact of any failure (Dalziell and McManus, 2004). Resilience is not only a matter of STM, but of soft infrastructure (the institutions and enterprises), which is also crucial for social and economic continuity (Omer et al., 2014). Maritime security is a whole of, at least, four concepts: sea power, marine safety, blue economy, and human resilience and the environmental issues are not only an important issue for maritime security, but also there are another core issues in multidisciplinary fields as economics, development, or global governance (Bueger, 2015).

To decrease vulnerability and increase resilience; security policies are established by governments and private entities and the impacts of security policy changes, with new security measures, may have both positive and negative effects on cost and port efficiency (Yeo et al., 2013).

2.3. Galician resilience

Villasante (2009) says that in the pre-disaster of the Prestige (1998–2001) stage fish landings in the Galician coast go down continuously (20.3%), a second phase (2002–2003), after the Prestige (marked in Fig. 2 with an arrow), continues the reduction of landed fish, which was intensified by a temporary cessation caused by the oil spill. After 2003, starts a third stage, marked by two sub-periods: in the first one, the effects of mandatory stop for the slick can be appreciated, which led to an increase of fish landings in post-Prestige (between 2003 and 2004); the second sub-period continued the same trend and increased by 38.7% the volume of fish landings between 2004 and 2007. (Garza-Gil et al., 2006a, 2006b; Loureiro et al., 2006; Negro et al., 2008; Negro et al., 2009) conducted a comprehensive analysis of the economic effects of the Prestige oil tanker fleet, the fact is that the volume of discharges had the lowest levels in 2001 with 6.3 million kg, and the highest records in 1997 and 2007. (Villasante, 2009). Overall, it can be stated that the Galician environment has a good level of resilience and recovery.

A large number of people are still maintaining their links with fishing, but due to continuous accidents and lack of strong institutional responses, population begins to feel helplessness and discouragement. Keep in mind that the resilience the resilience of coastal populations has been identified as a key factor in the emergence of maritime threats and is hence vital in their prevention (Bueger, 2015). Moreover, culture is crucial for resilience, this culture is based on confidence and accountability and then, people engage due their sense of a shared purpose (Omer et al., 2014).

Provision of clearing was established to offset the loss of income of the population (Negro et al., 2009), anyway, the fishing sector was severely affected. Gradually, the various fishing grounds reopened, however, the Death Coast was severely affected, both economically and ecologically (Fernández-Tajes et al., 2011) and recovery was very slow. According too Mira’s study (Mira, 2004), the main responsibility was attributed to the State Government (55.4%). Mostly, people assumed that the causes of the accident were policies (57.9%), compared to other causes of natural or technological nature. Although the resilience of environment seems to be clear, the resilience of population is not as straightforward, as is proved in this paper.

3. Method

3.1. The territorial disaggregation

The territorial Spanish organization divides the nation into a kind of federal states, called Autonomous Communities (Map 1), with their own Government and decision power over very wide political issues. Galicia is an Autonomous Community in the North West of Spain and it is made up of four Provinces: A Coruña, Lugo, Ourense and Pontevedra. Three of them have coastal areas: A Coruña, Lugo and Pontevedra (Map 1). Galicia has its own government for most of the common issues, even if it is under Spanish government for general territorial issues. In fact, the Spanish territorial organization decentralizes the legislative and administrative tasks. Regarding the protection of the marine environment, the national government retains exclusive responsibilities in the core legislation but the Autonomous Communities can carry out and extend the legislative framework.

The Spanish Autonomous Regions are divided into Provinces and those in Counties or Districts, which are formed by Municipalities (311), as it is shown in Fig. 3.

The territorial division in countries or districts does not reflect the differences between the coastal areas and interior places: as it is shown in Map 2, the Galician Districts are made up of a mix of coastal and no coastal areas. That is the reason why this study is focused on the lowest level of territorial disaggregation: the municipalities.

For our analysis, it would be desirable to use a data level which is disaggregated enough to separate different areas, depending on the degree of suffered contamination, but not so much fragmented as to complicate the study. For this reason the right level for Galicia would be the county or district, however, in the Galician regional structure, the regions are not separated by maritime and coastal areas and inland areas, but coastal counties are in turn made up of an important part of inside territory. In these circumstances we are forced to work with the most disaggregated data level available: the municipal level. Thus, based on municipal data, groups of municipalities were performed in the four following types:
Councils very affected by the spill, municipalities affected by the spill, coastal municipalities not very affected, and municipalities unaffected or not directly affected. In Table 2 are shown the affected municipalities. An analysis of means differences was carried out in relation to the degree of damage of municipalities, by the methods Student t test and ANOVA. Finally, a multivariate analysis was carried out to explain economic activity in terms of demographic variables and employment. A structural equation model (SEM) was designed. This method is a confirmatory factorial analysis that allows to work with latent variables or constructs, so that the constructs have the capacity or the ability to incorporate different aspects to the extent of the variables that we want to study, that being the economic activity (which is the dependent variable that will be explained), the demography and the employment variables (which are the explanatory or independent variables). Thus, all features and characteristics are collected through the latent variables.

3.2. The variables, the ANOVA and de structural equations modelling (SEM)

Our main goal is to explain the impact of the Prestige disaster on the lifestyle of the population, then, economic activity being crucial. The main areas of human aspects of economic activity are employment and demographics matters. That is why the level of dependence on fishing is mainly assessed on the basis of employment data in the area (Negro et al., 2009), and equal to other economic sectors. But both, demography and employment, an also the economy as a whole, are such a type of latent variables which are composite by several different issues and nuances constructing those variables. Then, first of all, an exploratory factorial analysis was conducted for the construction of latent variables to analyze:

Fig. 2. Monthly downloads of fresh fish in Galicia (kg). Source: (Villasante, 2009)

Fig. 3. Territorial structure of autonomous communities in Spain. Source: Authors own elaboration

the demography, the employment and the economic activity. Once the “constructs” or “latent variables” were assessed, a confirmatory factorial analysis was useful to explain the economic activity, as a dependent variable, through the demography and the employment. The purpose model is reflected in Graphic 1, and the composition of latent variables is explained forward.

As (Negro et al., 2009) pointed out, the economic evaluation of the Prestige impacts faces a number of methodological difficulties such as irregularities in data sets that indicate the economic activity prior to the disaster, problems in measuring the impact on non-market resources and the length of the impact effects in terms of time and space. Moreover, at the moment of the spill, one of the main pressures in the area was related to the activity of poachers from outside the village, mainly by incoming nocturnal scuba divers, especially prior to the Christmas season when some seafood species get their higher prices in the market (de Oliveira, 2013). So, the use of a cross-section analysis, pointing to two different periods is a good solution (ANOVA). Moreover, the “construction” of latent variables and the study of their inter-relationship (SEM) become a very good solution to solve the dynamic analysis problems due to lack of data.

4. The social effects of Prestige’s disaster

Maritime disasters, ultimately, can have a double impact. On the one hand, the physical impact resulting from the disaster itself and, on the other hand, the social impact, which is given by the social problems generated, for a time (Mira, 2004). The experience of the Prestige accident has allowed determining the existence of two big focal points of performance and behavior on the part of some operators. On the one hand, we have highlighted a significant spread of small companies in charge of the transport of dangerous goods in conditions of informal economy (González-Laxe, dir, 2003). These are companies registered in tax heavens, with an accountant organization difficult to track; companies that are created and disappear very quickly to avoid the controls, they are acquired in an open market at very low prices without having total or strict security conditions for both the vessels and the crew. On the other hand, the international institutional framework does not manage to design a regulation system that allows avoiding, mitigating or reducing the negative impacts in the cases in which these situations regarding maritime business happen.

That is because there are not restrictions or severe rules to achieve a good sectorial performance. Analyzing the EU maritime policy, which focuses on capital mobility as a critical parameter that constraints regional authority-building and argues that public policies are closely related to foreign direct investment of capital global requirements because “mobile business... is less willing to bear new regulatory and distributive burdens at either the European or state level than otherwise would be” and shipping is “the apotheosis of capital mobility” (ibid., p. 23). In other words, the globalization of the industry and the power of shipping capital has occurred very quickly to avoid the controls, they are acquired in an open market at very low prices without having total or strict security conditions for both the vessels and the crew. On the other hand, the international institutional framework does not manage to design a regulation system that allows avoiding, mitigating or reducing the negative impacts in the cases in which these situations regarding the maritime business happen.

Therefore, if we analyze the evidence provided by the Prestige accident in the light of the public economy, it can be stated that there are two clear negative guidelines on which to take measures: on the one hand, there is still a significant lack of anticipatory prevention measures to reduce the negative impacts, and, on the other hand, there is not enough exploitation of the sanctioning capacity that becomes obvious in view of the laxity these interventions take place in.

4.1. The changes in normative environment after Prestige

The application of post-Prestige regulations could be classified as “a succession of chained failures”. That is because the difference between fleet capacity (supply) and demand for freight is one of the explanations of the use of sub-standard ships, with structural features that makes more difficult the straight subsection to international laws, this situation causing the emergence of new strategies in order to minimize the application of those normative conditions.

Table 2
Municipalities affected by Prestige’s spill.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabana de Bergantinos</td>
<td>Betanzos¹</td>
</tr>
<tr>
<td>Camariñas²</td>
<td>Cabanas¹</td>
</tr>
<tr>
<td>Carnota¹</td>
<td>Cambroº</td>
</tr>
<tr>
<td>Corcubión¹</td>
<td>Cedeira¹</td>
</tr>
<tr>
<td>Fisterra¹</td>
<td>Coruña, A</td>
</tr>
<tr>
<td>Laxe¹</td>
<td>Dumbria¹</td>
</tr>
<tr>
<td>Ponteceso¹</td>
<td>Fene¹</td>
</tr>
<tr>
<td>Vigo⁵</td>
<td>Laracha, A</td>
</tr>
<tr>
<td>Cambados³</td>
<td>Manón</td>
</tr>
<tr>
<td>Catoira³</td>
<td>Mugardos³</td>
</tr>
<tr>
<td>Meano⁴</td>
<td>Narón⁴</td>
</tr>
<tr>
<td>Boiro⁵</td>
<td>Neda⁴</td>
</tr>
<tr>
<td>Cee⁵</td>
<td>Noia⁴</td>
</tr>
<tr>
<td>Malpica¹</td>
<td>Ortigueira⁴</td>
</tr>
<tr>
<td>Pobra do Caraminal, A</td>
<td>Outes¹</td>
</tr>
<tr>
<td>Rianxo²</td>
<td>Paderne¹</td>
</tr>
<tr>
<td>Vilagarcía de Arousa, A</td>
<td>Caniño¹</td>
</tr>
<tr>
<td>Illa de Arousa, A²</td>
<td>Buer¹</td>
</tr>
<tr>
<td>Muxía⁵</td>
<td>Marín⁵</td>
</tr>
<tr>
<td>Ribeira¹</td>
<td>Pontevedra⁴</td>
</tr>
<tr>
<td>Vilanovo de Arousa¹</td>
<td>Poio⁵</td>
</tr>
<tr>
<td>Grove, O³</td>
<td>Ribadumia¹</td>
</tr>
<tr>
<td></td>
<td>Rosal, O³</td>
</tr>
</tbody>
</table>

¹ Province of A Coruña.
² Province of Pontevedra.
stipulated by the international law. Some of the most common
lacks of this kind of ships are the age of the vessel, the character-
istics of the hull, the cargo carried, free flag, the flag of convenience,
among others, which drives to search for some dodges for sub-
standard ships solving this trouble. Ecology, economy or employ-
ment constituted the main axis to explain the public perception of
the consequences of this disaster (Mira, 2004).

4.2. The configuration of institutional offices to prevent and afford
environmental disasters

To properly assess the impact of environmental disasters, such
as the Prestige one, it should be taken into account the impact of
direct costs, and also cost of mitigation measures implemented by
the central and autonomous governments, plus the indirect eco-
nomic impact and the outcomes, both the direct ones and the in-
direct, on intangible assets. Table 3 reflects the paper of more
significant Spanish and European regulations and some observa-
tions about its roles and functions.

The Prestige disaster revealed the limitations within the Spanish
system for these types of issues. In case of marine disasters, Spain
has an “own system” where state intervention is strong. The
emergency planning was defined in the Law of Ports and Merchant
Marine (1992). Only much later, and in parallel updating several
regulatory provisions and the transposition of EU directives,
derived from “European packages” Erika I and Erika II, it was
approved the establishment of CEPRECO (Centre for Disease Pre-
vention and Control marine pollution and coastal), under the
Ministry of Presidency (RD 2182/2004). Briefly, its objective being
to analyze existing protocols and action plans in crisis situations. To
do this, it must have Territorial Emergency Plans for Marine
Pollution that included the development of operating procedures;
the availability of sufficient resources and in real time; suitably
trained and updated; available prediction tools; and a reliable
system of information dissemination. It was in 2010, when Spain
approved the marine rescue plan (Spanish Government, 2010).

The existence of CEPRECO was ephemeral. It only remained for
four years. It was closed in 2008 (RD 438/2008 of 14 April), taking
advantage of a change in the basic organizational structure of
ministerial departments; and its functions are taken over by the
Department of Sustainability of the Coast and the Ocean, the
Ministry of Environment and Rural and Marine Environment.

4.3. The sentence of Prestige

The judgment was very exhaustive. It says "after 10 years of investigation procedure and 9 month trial, no one knows exactly what has been the cause of what happened, or what should have been the appropriate response to the emergency situation created by the serious fault of Prestige, irrespectively of the multiple and, sometimes, curious hypotheses that have been supported on both ends ";(page 165).

Also it is said in the judgment (page 252):

- Apparently, the effects of oil on coastal ecosystems exposed to sea are of short duration and the flora and fauna re-colonize quickly;
- There is an obvious dysfunction between the compensation ordered and the ones certified in this trial, as is the spending assumed by the State and by the Xunta de Galicia;
- Determining the extent of the damage on the impact of repair and compensation can only be documentary credited by invoices or unchallenged accounting.

The verdict has been delivered only by disobedience, and it can't be associated to the damage to the offense and, therefore, can't be determined who is the responsible and should bear civil compensation, which was stood at 4.328 million euros by the prosecutor.

The court considers it proven that the oil spill had caused "massive" damages and severe economic consequences, due to the Prestige oil spill, but not attached to anyone, because this would have required that someone had committed a crime of damage. It states (page 187) "In short, there is no specific evidence to establish with certainty the causes of the extraordinary, sudden and irreparable breakdown suffered by the ship in front of the Galician coast (...) and can only be inferred from the data collected that the state of maintenance and/or ship maintenance was deficient and that it caused that the vessel could not bear the efforts of such a remarkable temporary action". This judgment reinforced the feelings of helplessness of the population towards the institutions, in case of maritime disasters.

5. Results: the effects of disaster in lives of population in the area: fishing and economic activity

The accident has shown great inefficiencies in the ability of responding in crisis situations (Freire et al., 2006). Moreover, there was a perceived lack of transparency in the media coverage of the disaster led to numerous civil protests (Pérez, 2003). The catastrophe fostered a significant social change which resulted in increased activism and solidarity, as shown by the thousands of volunteers that helped cleaning the shores (Azeiteiro et al., 2012).

5.1. Fisheries

Basic aspects of human security are related to food safety concerns, housing, sustainable livelihoods and job security, and fishing is a vital source of food and employment (Buégé, 2015). The demographic and employment factors are one of the stressors of human social systems dependent on marine ecosystems (Perry et al., 2010). Galicia is the main fishery region in Europe. It represents about 10% of the overall European fleet sector in terms of (78%), capacity (9.9%), catch (10.3%), catch value (16.3%) and employment (10.6%). The participation of the Galician fishing sector in GDP is 2.4% while the EU fishing sector represents 0.1% of GDP.

Our main hypothesis is that primary sector was affected by the prestige disaster, and it is shown in a decreasing weight of it in employment:

\( H_0: \) The employment in Primary Sector remain after Prestige's catastrophe.

To analyze the impact on fisheries, related to the importance as an income source for local population, it was studied the population's labor occupation in the main sectors of economic activity: Agriculture and Fisheries, Industry, Construction and Services. The years considered were from 2002 to the present.

Firstly, a factorial analysis was conducted for years 2002, 2005 and 2013, for testing our hypothesis \( H_0 \). Results are shown in Table 4 and Graphics 2, 3 and 4.

In spite of this no homogeneous patterns in landing behaviors have been identified. Some species clearly diminished while others increased and it was observed a disruption in the cycle of landings after the oil spill, after modelling a scenario in the absence of the accident. This indicates an unusual evolution of landings, given that if the spillage had not occurred, the seasonal features would not have suffered major changes (Negro et al., 2009). It seems to have to do with different factors to the environmental impact ones.

<table>
<thead>
<tr>
<th>Year</th>
<th>Estimate</th>
<th>S.E.</th>
<th>C.R.</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0.904</td>
<td>2132</td>
<td>17,572</td>
<td>***</td>
</tr>
<tr>
<td>2005</td>
<td>0.881</td>
<td>1338</td>
<td>31,227</td>
<td>***</td>
</tr>
<tr>
<td>2013</td>
<td>0.707</td>
<td>0.001</td>
<td>17,145</td>
<td>***</td>
</tr>
</tbody>
</table>

\( ***P < 0.001. \)
Results confirm the decreasing coefficient for Agriculture and Fisheries, so that we must reject our hypothesis and we can't conclude about Fisheries.

5.2. Population resilience: Galician economic structure & employment

The specific peculiarities of the economy of Galicia can be summarized in a low disposable income, with reduced levels of operating surplus (in line with fluctuations in production based on the exploitation of natural resources) and lower tax contributions, given the low levels of benefits.

Sectorial employment differences were analyzed. To test the differences between affected areas (in general terms, independently of affectation grade) and not affected areas (both coastal not affected and inland) it was studied the means comparison with a Student test and we appreciate significant differences between affected and not affected areas for all items except for Employment contracts in Services during years 2002 and 2003, showing higher levels for all years, the affected area related to the not affected one. For a more detailed analysis ANOVA was conducted. Four geographic areas were considered: hardly affected areas, affected, coastal unaffected areas and interior or inland. The Levene test, previous to the ANOVA, shows different variances between groups for all sectors and for all years. Our hypotheses regarding to sectorial analysis were:

- Hypothesis H0S1: There are no differences in average employment between different coastal areas, regardless of the degree of involvement by the spill.
- Hypothesis H0S2: There is no difference in average employment between unaffected coastal areas and interior zones.
- Hypothesis H0S3: There is no difference in average employment in Primary Sector between very affected areas and interior zones.
- Hypothesis H0S4 There is no difference in mean employment in Primary Sector between affected areas and interior zones.
- Hypothesis H0S5: There are no Differences in mean employment in the hard-hit industry area and the other areas.

Due the different variances for the groups, a Post-Hoc Test Games Howell Test was conducted (and also a T-The Tamhane T-2 test, which showed the same results). In Table 5 it is show the significant mean difference taken from the Games Howell test, and all of them are in Very affected or affected areas for years from 2002 to 2005. Results show a different behavior of both types of affected areas. If we make a difference between the whole affected areas and the rest of Galicia (both coastal and not coastal municipalities not affected) we can appreciate that the first ones 1) are much more dependent on services sector, and 2) are significantly more sensitive to economic environmental issues on Primary Sector.

No differences in means between affected areas and very concern, none for year, neither for any economic sector. However when the unaffected areas (coastal or inland) were compared with either one of the two level affected areas, it was found that the hard-affected area showed differences that were not detected in the affected area. Although broadly affected and affected areas showed very similar situations, detailed analysis indicated the spill's impact was different in less affected areas than in those most affected.

Hypothesis H0S1 was accepted for all sectors of the economy, except for the case of industry for the comparison of very affected area with the coastal area unaffected. The explanation for this situation could be the transfer of activities from the canning industry which went far for more affected areas, which were paralyzed in the highly affected area. This conclusion was also given from hypothesis H0S5 through another reasoning: this hypothesis (H0S5) is accepted when the area strongly affected is in comparison with the affected one, however, is rejected when a comparison with the inner and coastal areas unaffected is being made.

Hypothesis H0S2 was accepted, while Hypotheses H0S3 and H0S4 were rejected. The rejection of the hypothesis H0S3 and H0S4 showed differences in employment in the primary sector in the affected areas, in relation to any other area of Galicia, so the impact of the spill is displayed.

5.2.1. Multivariate analysis: demography and employment explaining economic activity

In this section, it was carried a multivariate analysis to explore relations between the three main issues for the lifestyle of population. Firstly we have elaborated the latent variables “demography”
(through the indicators in Table 6) and the “employment” (Table 6) as it was already explained (see Graphics 2, 3 and 4) and economic activity (Indicators are in Table 6). The model to test responds to the Graphic 1, and results are in Graphic 5.

Due to the fact that the life of population is related with demography, employment and economic activity, the hypotheses that are to be tested are:

- **H0G1**: The demography of societies is not relevant for economic activity.
- **H0 G2**: The employment level is not relevant for economic activity.
- **H0G3**: The Galician economic activity is not explained by the demography of society and the employment level.

Results indicate that all hypotheses must be rejected. Table 7 showed how demography and employment are highly significant to explain economic activity ($p < 0.001$). The negative sign of employment does not match with economic theory and can only be explained through the high level of black economy. Moreover, the fitting of the model is acceptable (CFI = 0.926) and the squared multiple correlation for the dependent variable is 0.970, which means that the variability of Galician economic activity is explained by the independent latent variables employment and demography in the 97%. Coefficients for items of each independent variable are shown in Graphic 5, which reflects the whole model results.

### 6. Discussion and conclusions

Conclusions arisen from normative analysis indicate that it is necessary to create preventive institutional mechanisms by means of clearly specified rules and controls, together with the identification of agencies responsible for development and execution of proposals, able to generate confidence in the local population and respond appropriately to prevent potential disasters. Maritime security is still a pending issue in Galicia, because, as it was shown by the Prestige’s sentence, Policies to reduce the impacts of maritime disasters evolve slowly, the same as the criminalization of unsafe practices.

European countries have substantially increased control devices and compensation schemes, although there still are limits to the latter, but it is not possible to say yet that all the damage is fully compensated. From the Prestige disaster, the EU and the Spanish State stressed the need for more stringent criteria in regards to maritime traffic and control. However, international regulations and their harmonization has always been the more relegated.

In the Spanish case, it is striking the prompt government response to both compensation and mitigation measures, such as the manipulation of devices and media, and as the prompt solution of these once scarce elapsed. The case CEPECO is symptomatic of what noted.

As the resilience of coastal populations has been identified as a key factor in the emergence of maritime threats and is hence vital in their prevention (Bueger, 2015), it is a core issue to assess the impact of maritime disasters in population’s way of life. Overall, it can be stated that the Galician environment has a good level of resilience and recovery. Although the resilience of environment seems to be clear, the resilience of population is not as straightforward, as is proved in this paper.

There is still a significant lack of anticipatory prevention measures to reduce the negative impacts, and, on the other hand, there is not enough exploitation of the sanctioning capacity that becomes obvious in view of the laxity these interventions take place in.

Although broadly affected and affected areas showed very similar situations, detailed analysis indicated that the impact of the spill was different in less affected areas than in those most affected.

### Table 5

<table>
<thead>
<tr>
<th>Differences between municipalities by affected areas</th>
<th>Employment contracts 2002 – 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture &amp; fisheries</td>
</tr>
<tr>
<td>Very affected &amp; affected</td>
<td>No mean differences</td>
</tr>
<tr>
<td>Very affected &amp; coastal not affected</td>
<td>No mean differences</td>
</tr>
<tr>
<td>Very affected &amp; interior</td>
<td>0.045 (a), 0.081 (b), 0.052 (c), 0.027 (d)</td>
</tr>
<tr>
<td>Affected &amp; coastal not affected</td>
<td>No mean differences</td>
</tr>
<tr>
<td>Affected area &amp; interior</td>
<td>0.076 (b), 0.018 (c), 0.052 (d)</td>
</tr>
<tr>
<td>Coastal not affected &amp; interior</td>
<td>No mean differences</td>
</tr>
</tbody>
</table>

(a) 2002, (b) 2003, (c) 2004, (d) 2005.

### Table 6

<table>
<thead>
<tr>
<th>Latent variables and items.</th>
<th>Economic activity</th>
<th>Employment</th>
<th>Demography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total contracts in services</td>
<td>Services</td>
<td>Industry</td>
<td>Young</td>
</tr>
<tr>
<td>Total contracts in industry</td>
<td>Industry</td>
<td>Construction</td>
<td>Old</td>
</tr>
<tr>
<td>Total contracts in construction</td>
<td>Construction</td>
<td>Agriculture and fisheries</td>
<td>Growth</td>
</tr>
<tr>
<td>Total contracts in agriculture and fisheries</td>
<td>Agriculture and fisheries</td>
<td></td>
<td>Aging</td>
</tr>
<tr>
<td>Total contracts in services</td>
<td>Services</td>
<td>Industry</td>
<td>Young</td>
</tr>
<tr>
<td>Total contracts in industry</td>
<td>Industry</td>
<td>Construction</td>
<td>Old</td>
</tr>
<tr>
<td>Total contracts in construction</td>
<td>Construction</td>
<td>Agriculture and fisheries</td>
<td>Growth</td>
</tr>
<tr>
<td>Total contracts in agriculture and fisheries</td>
<td>Agriculture and fisheries</td>
<td></td>
<td>Aging</td>
</tr>
<tr>
<td>Percentage of population &lt;20</td>
<td>Young</td>
<td></td>
<td>Active</td>
</tr>
<tr>
<td>Percentage of population &gt;65</td>
<td>Old</td>
<td></td>
<td>Migration</td>
</tr>
<tr>
<td>Continuous compound growth rate</td>
<td>Growth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index of aging</td>
<td>Aging</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Index structure of working age population</td>
<td>Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Migration balance</td>
<td>Migration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All data are from 2003.
Lives of population in affected areas were impacted by a change in the number of foreigner people visiting their places, due to the massive affluence of volunteers to the affected areas during the years 2002 and 2003. In this situation it was an impressive humanity movement, of helping to fight against pollution, through a very important labor solidarity work coming from everywhere.

It is feasible to asses that Galician economy is highly linked to demographic factors and employment, but these latent variables are affected by maritime catastrophes. As in Galicia maritime disasters take occur a periodically, and some of the protectative institutions are now out of order, it would probably be expected that in the future it could be another similar situation, then, these expectations could affect population way of living, boosting migrations to avoid suffering a new catastrophe, and inducing changes in demography and in the economic structure of Galician coastal areas.

The authors would like to point that this research shows the limitation of not having a qualitative research, which should be taking place to improve the quantitative analysis here presented.

### References


### Table 7

<table>
<thead>
<tr>
<th>Demography</th>
<th>Estimates</th>
<th>0.047</th>
<th>44,362</th>
<th>3339</th>
<th>***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>–284,153</td>
<td>–0.973</td>
<td>8533</td>
<td>−33,301</td>
<td>***</td>
</tr>
</tbody>
</table>

***P < 0.001.


