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From Oil Spills to Ocean Literacy Maritime Education and the Legacy of Environmental Accident

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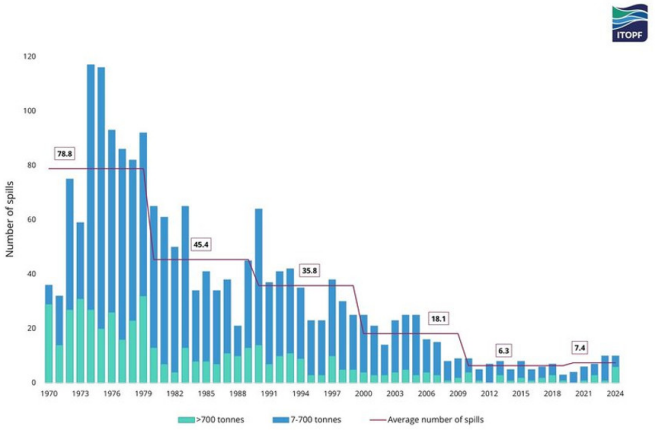
ABSTRACT

This paper analyzes how major maritime ecological disasters –Exxon Valdez (1989), Erika (1999), and Prestige (2002)– acted as catalysts for the transformation of nautical education, prompting regulatory and curricular changes geared toward sustainability and environmental awareness [1].
A mixed-methods approach (historical document and curriculum analysis) is employed to assess the integration of environmental content into maritime education programs.
The central concept is Ocean Literacy, defined as "an understanding of the ocean's influence on you and your influence on the ocean" (Cava et al., 2005). It is grounded in seven essential principles and 45 concepts articulated by NOAA (2013, 2024) and supported by UNESCO (Schoedinger, 2020). Its goal is to foster critical thinking, environmental ethics, and active participation in ocean policy [2][3][4].
The hypothesis suggests that sustainability in maritime education in Spain emerged reactively –spurred by environmental crises– rather than from pre-existing initiatives. The analysis is organized into three lines: 1) landmark accidents as drivers of reform; 2) a review of nautical degree curricula before and after 2002/2003; and 3) international regulatory developments, including MARPOL, STCW, and European strategies such as Blue Growth [5].
The article proposes going beyond mere regulatory compliance toward experiential and integrated education, where Ocean Literacy serves as a cross-cutting axis, applied through incident simulations, service-learning projects, and international faculty collaboration [6].

1. Introduction.

Since the mid-20th century, the maritime transport of hydrocarbons has experienced exponential growth, becoming the backbone of global trade. By 2024, although the number of major oil spills has significantly decreased, ten large-scale incidents (over 7 tonnes) were still recorded—six classified as major and four as medium spills—representing an average of 7.4 incidents per year over the last decade, a figure still notably higher than in previous decades [7].

Figure 1: Number of medium (7-700 tonnes) and large (>700 tonnes) tanker spills, 1970-2024.



Source: itopf.org.

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A turning point was marked by three catastrophic accidents: *Exxon Valdez* (1989), *Erika* (1999), and *Prestige* (2002). These events, widely covered by the media, exposed critical shortcomings: crews unprepared for environmental emergencies, outdated protocols, and uncoordinated institutional responses [8].

A paradigmatic example of media impact is the *Prestige* disaster. Comparative framing studies show that the regional Spanish press maintained more consistent coverage focused on local economic effects, while national newspapers emphasized ecological consequences and political responsibility, fueling social mobilizations like the "Nunca Máis" movement [9].

Figure 2: The oil tanker Prestige broken in two, in a photograph taken in November 2002.

Source: EFE.

In the case of *Exxon Valdez*, NOAA acknowledged that this spill "prompted a review of oil spill prevention, response, and cleanup strategies" [8], leading to the enactment of the U.S. Oil Pollution Act (1990), which mandated double-hulled tankers and required specialized training modules on spill management [10].

In parallel, the concept of Ocean Literacy emerged, defined as "understanding the ocean's influence on you and your influence on the ocean" [11]. This framework is grounded in seven essential principles and 45 concepts and is promoted by UNESCO-IOC and NOAA to encourage critical thinking, ecological ethics, and civic engagement in addressing ocean challenges [12].

This study is based on the hypothesis that sustainability in Spanish maritime education emerged reactively, in response to environmental crises, rather than as a result of proactive educational planning. The analysis is structured around three main axes: (1) maritime disasters as drivers of regulatory and educational change, (2) curricular review before and after the *Prestige* incident, and (3) the integration of international frameworks—MARPOL, STCW, and strategies like Blue Growth—into academic maritime content.

Finally, the paper advocates for a shift toward immersive and transformative education, in which Ocean Literacy is implemented through real - world simulations, Service-Learning projects, and transnational academic cooperation [13].

2. Development.

2.1. Landmark accidents as drivers of change.

2.1.1. Exxon?Valdez (1989, Alaska).

Figure 3: The Exxon Valdez being towed after causing an ecological disaster in Alaska in 1989.

Source: AP.

On March 24, 1989, the oil tanker *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, spilling approximately 41 million liters of crude oil. The spill affected more than 2,000 kilometers of coastline and caused the most significant ecological disaster in Alaska's history [13]. This catastrophe exposed serious failures in emergency preparedness, insufficient contingency planning, and maritime training that lacked an environmental response focus [14].

The response was swift: NOAA deployed an unprecedented operation, mobilizing scientists and personnel over a six-month period, laying the foundation for a large-scale cleanup strategy [15]. As a direct consequence, the United States passed the Oil Pollution Act of 1990, which established federal funds for spill response, mandated double-hull tankers, and introduced new mandatory training modules in maritime education institutions [16].

2.1.2. Erika (1999, France).

Figure 4: Erika oil tanker accident (1999).

Source: elpais.com.

On December 12, 1999, the single-hull oil tanker Erika broke in two off the coast of Brittany, releasing between 10,000 and 20,000 tonnes of fuel oil along nearly 400 kilometers of French coastline [17][18]. This incident highlighted the structural limitations of single-hull vessels and the inadequate technical inspections performed by classification societies [17].

In response, the European Union introduced the Erika I legislative package (2000), which established a mandatory timeline for phasing out single-hull vessels and reinforced port auditing systems across Europe [17][19].

2.1.3. Prestige (2002, Spain).

On November 13, 2002, the single-hull oil tanker Prestige sank off the coast of Galicia following a structural failure, releasing up to 60,000 tonnes of fuel oil and polluting approximately 2,300 kilometers of coastline across Spain, France, and Portugal [20]. The controversial management of the incident by national authorities –including delays in towing and prolonged discharges– sparked public outrage and led to the rise of the grassroots movement "Nunca Máis" [20].

Figure 5: Nunca Máis demonstration in Madrid, February 2003.

Source: elpais.com.

On the regulatory front, the Prestige disaster prompted a major overhaul of Spanish and EU legislation, including the accelerated ratification of MARPOL amendments, enhanced technical inspections, and the integration of preventative criteria into maritime training programs [21][17].

Each of these three accidents had a decisive impact on the design of maritime training protocols. The shift ranged from reactive emergency simulation and rapid response strategies to the incorporation of content on sustainability, double-hull technology, and professional ethics. The next section will analyze how these changes were reflected in Spain's curricular frameworks.

3. Documentary analysis of Curriculum changes in the Canary Islands.

3.1. Maritime-Fisheries Institutes of Tenerife, Gran Canaria and Lanzarote.

The vocational maritime-fisheries training centers in the Canary Islands adapt the national curriculum to their insular context. The Maritime-Fisheries Institute of Santa Cruz de Tenerife, active since 1986, offers intermediate and advanced vocational programs that include modules on navigation, fishing, and marine machinery. These programs incorporate practical training in simulators, marine biology laboratories, hyperbaric chambers, and on-board drills using their own vessels [22].

Its curriculum clearly includes environmental content such as waste management and marine pollution prevention, alongside basic training in safety, first aid, and emergency management. These components align with MARPOL and STCW requirements [22][23].

Located in Las Palmas, the Maritime-Fisheries Institute of Gran Canaria follows a similar structure, integrating environmental safety modules into higher-level programs such as Supervision and Control of Ship Machinery and Installations and Navigation, Fishing, and Maritime Transport. These programs are complemented by internships at Canarian ports and ongoing training opportunities [23].

In Lanzarote, the fisheries vocational institute introduced in 2024 an AENOR environmental management certification. Its facilities are equipped to assess local environmental impact, thereby reinforcing pollution prevention protocols and procedures for responding to hydrocarbon accidents [23][26].

3.2. University of La Laguna (ULL) - Degree in Nautical Science and Maritime Transport & Marine Technologies.

3.2.1. Degree in Nautical Science and Maritime Transport (240 ECTS, 4 years).

The curriculum of this program reflects an integrated approach combining technical training with environmental education. In addition to the traditional module Fundamentals of Navigation, the program includes key subjects such as:

- Maritime Safety, Firefighting, and Survival at Sea (12 ECTS, 2nd year), which includes training in oil spill prevention and emergency response [24].
- Marine Safety and Pollution (6 ECTS, 4th year), a compulsory, hands-on subject that uses bridge simulators to train students in spill protocols and emergency procedures [24].

External internships (60 ECTS) take place in Canarian ports, merchant vessels, and environmental institutions, allowing students to apply contingency models and MARPOL regulations in real-world contexts [24].

The final degree project (12 ECTS) allows students to conduct research-based projects in areas such as:

- Environmental risk assessment

- Development of prevention plans
- Implementation of Ocean Literacy tools adapted to the Canary Islands [24]

These curricular structures are endorsed by BOE-A-2012-10512, which officially establishes the program's academic content [24].

3.2.2. Degree in Marine Technologies (240 ECTS, 4 years).

This program qualifies graduates as Engine Officers of the Merchant Marine, according to the STCW-A-III code [25]. It features several environmentally focused subjects, including:

- Corrosion and Material Degradation, which promotes vessel durability and the prevention of pollutant leaks [25].
- Quality Engineering, which integrates environmental management systems into the operational life cycle of onboard systems [25].
- Naval Machinery Regulation and Control, which covers technologies to reduce NOx and SOx emissions [25].

Both elective and mandatory professional internships are conducted in real-world settings, focusing on the environmental monitoring of maritime machinery, in alignment with international atmospheric pollution standards [25].

4. Regulatory evolution: From MARPOL to STCW-F and its impact on training.

4.1. MARPOL (1973/78).

The MARPOL Convention, adopted in 1973 and amended in 1978, stands as the principal international instrument to prevent ship-source pollution. It comprises six annexes regulating the discharge of oil, noxious substances, ballast water, garbage, and atmospheric pollution [26]. The effectiveness of MARPOL relies heavily on national implementation and crew training in environmental control, record-keeping, and management practices. Since 2002, these elements have been integrated into vocational and university maritime curricula in Spain.

The EMSA Strategy 2020–2024 further reinforces this training by identifying pollution prevention education as a priority and promoting the development of courses and workshops for administrations and seafarers [27].

4.2. STCW (1978) and its amendments (1995, 2010).

The STCW Convention, established in 1978 and amended in 1995 and 2010, sets minimum training standards for seafarers, extending its scope to marine environmental protection [28][29].

The 2010 amendments ("Manila Amendments") strengthen training on modern technology and environmental awareness, incorporating these topics into mandatory basic training [29].

4.3. STCW-F (1995).

The STCW-F Convention, adopted in 1995 and enforced from 2012, introduces specific standards for fishing vessel crews, incorporating training on maritime safety and protection aimed at reducing accidents and pollution in the fisheries sector [30].

*Complementary european regulations: EMSA, Green Deal, and Blue Growth*The European Maritime Safety Agency (EMSA) plays a key role in supporting Member States on environmental regulations and operational safety training [27]. EU strategies such as the Green Deal and Blue Growth emphasize maritime education as a pillar of sustainability, promoting transversal competencies in ocean literacy, technological innovation, and blue economy development [28].

5. Methodology.

This study employs a mixed-methods approach, combining documentary analysis and case studies, applied to maritime institutions in the Canary Islands (ULL and three Maritime-Fishing Institutes). This approach enables an in-depth exploration of both training structures and implemented practices.

Documentary Analysis: Official curricula were reviewed (ULL Degree programs, Canary Islands vocational training curricula, Royal Decree 1691/2011) alongside international regulations (MARPOL, STCW, STCW-F) to map the evolution of environmental training. The use of a concurrent-parallel data design, typical of mixed-methods research, allows for the integrated analysis of qualitative and quantitative data.

Case Study: A structured template was applied in the three selected institutions to evaluate context, curricular structure, environmental practices, and the integration of simulations and emergency training in the classroom. The gap analysis methodology in Maritime Education and Training (MET) proposed by Farag et al. (2021) – IAMU was followed.

Conclusions.

Throughout this article, it has been demonstrated that maritime accidents such as Exxon Valdez, Erika, and Prestige triggered international regulatory reforms (MARPOL, STCW, STCW-F) and prompted a revision of the maritime educational approach in Spain, particularly in the Canary Islands.

However, these reforms have largely been regulatory responses rather than a deliberately planned educational strategy. Rowihil and Farag (2021) advocate for the urgent implementation of a sustainable maritime education model (SD MET), which integrates values, ethics, and active participation, rather than merely meeting the minimum STCW requirements.

Simultaneously, the integration of ocean literacy through active methodologies—such as problem-based learning, service-learning, and interdisciplinary simulations—has shown significant impact. UNESCO (2025) emphasizes the need to incorporate the ocean into educational systems, while NOAA and NMEA demonstrate that mastery of oceanic principles strengthens professional identities aligned with sustainability.

The following actions are recommended:

- Adopt active methodologies in maritime training (spill simulations).
- Promote continuous education focused on emerging challenges (decarbonization, climate change).
- Establish cooperative networks in the Canary Islands amid ULL, port authorities, and institutions to share experiences.
- Include indicators linked to SDGs 13 and 14 in academic projects and internships.

Only through education that transcends regulatory compliance can a maritime sector committed to ocean literacy, environmental resilience, and professional responsibility be achieved.

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