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Target objectives in Spanish Marine Science within the European context (2003-2007)

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SUMMARY: The analysis of the marine projects funded by the Spanish RTD funding agency between 2003 and 2007 in the framework of the European policies, showed that although the funds available have increased (232 projects and 33 Million € from 2003 to 2007) there are still research and strategic areas that are not covered. The relevance of marine related services and economic revenues for Spain requires that a strategy is developed to address the challenges that are emerging due to the growing competing uses of the sea, which include maritime transport, fishing, aquaculture, leisure activities, off-shore energy production and other forms of seabed exploitation. By helping to develop a more sophisticated understanding of the impact of human activities on marine systems, scientific research and technology may provide the key to carrying out sea-based activities without degrading the environment, and to predicting and mitigating as far as possible the effects of climate change.

Keywords: research, key issues, marine sciences.

RESUMEN: OBJETIVOS CLAVE DE LAS CIENCIAS MARINAS ESPAÑOLAS EN EL CONTEXTO EUROPEO (2003-2007). – Dentro del marco de las políticas europeas, el análisis de los proyectos sobre el medio marino sufragados por la Agencia Española de Investigación, Desarrollo e Innovación (I+D+I) durante los años 2003-2007 pone de manifiesto que, aunque se han incrementado las subvenciones concedidas (232 proyectos y 33 millones de euros en dicho período), existen todavía sin cubrir determinadas áreas estratégicas y de investigación. La relevancia para España de los servicios e ingresos económicos relacionados con el medio marino requiere que se desarrolle una estrategia que dirija los desafíos resultantes de la creciente competencia de usos que el mar genera, tanto desde el punto de vista del transporte marítimo, la pesca, la acuicultura, el ocio, la producción de energía en mar abierto, como de otras formas de explotación del fondo marino. Para ayudar a desarrollar una mejor y más sofisticada comprensión del impacto de las actividades humanas sobre los sistemas marinos, la investigación científica y la tecnología deben ser capaces de proporcionar las claves necesarias para desacoplar de la degradación ambiental las actividades de explotación relacionadas con el mar, de modo que se predigan y atenúen tanto como sea posible los efectos del cambio climático.

Palabras clave: investigación, cuestiones clave, ciencias marinas.

INTRODUCTION

The oceans are of major strategic importance to the economic and social development of Europe. Marine research is a complex domain that requires large investment in resources, which includes securing competent human resources, obtaining vast observational data, developing complex numerical models and employing supercomputers, all of which can best be mobilised by joint efforts. Moreover, as marine research addresses topics that range from climate studies to biodiversity, it is intrinsically an international multidisciplinary activity. The European Union (EU) is constructing a common European research area. One of the main tools is the ERA-NETs (ERA: European Research Area), which

aim to harmonise the national funding agencies to develop common procedures for research funding in EU countries. One of these ERA-NETs is MarinERA (http://www.marinera.net) a project funded by the EU FP6 (6th Framework Programme for Research and Technological Development) ERA-NET Scheme (2004-2008). MarinERA is a partnership between the leading Marine RTD (Research and Technological Development) Funding Organisations in 13 European Member States. In addition, a range of observers are associated with the project. MarinERA aims to coordinate the national and regional RTD marine science activities in general. One of its particular objectives is to identify the research priorities of the marine sciences. These were pin pointed in the European Science Foundation (ESF) Document Navigating the Future (EU 2007). Significant research is needed to inform, provide support for and implement existing and emerging robust European policies. Existing and new knowledge should be used to promote development of evidence-based policy regulation and management.

A knowledge-based approach should be adopted to elaborate a range of European maritime policies, whether sectorial (research, energy, fisheries, transport, security) or general (European Maritime Policy). A knowledge-based approach is also required to implement the Sixth Environmental Action Plan and associated thematic strategies, research framework programmes and directives (e.g. European Marine Environment Strategy, Water Framework Directive, Integrated Coastal Zone Management [ICZM] Strategy, Natura 2000). Strengthening the science-base of these and related policies should be an inherent requirement in their implementation. The European Commission's Green Paper on Maritime Policy must be supported by excellence in marine research, technology and innovation (ESF-Marine Board, 2007).

Therefore, the research community must rise to the challenge of effectively fulfilling the national research needs, by applying for the competitive funding for research. Spain promotes research through Framework Plans and annual calls for project proposals funded mainly by the Ministry of Science and Innovation (MICINN). These calls for project proposals in previous national Research Plans (1995-2007) had specific objectives for each programme (Morales-Nin and Sánchez, 2004). However, in the new framework launched in 2007 a bottom up approach is followed, without specific objectives specified.

The objective of the present document is to review the projects funded by the Ministry of Science and Innovation (former Ministry of Education and Science), the main funding agency for RTD in Spain, in the last 5 years to determine the deficiencies and strongholds of the marine scientific community. The analysis was carried out with respect to European priorities, which are the natural framework for the Spanish scientific community. Our aim is to identify the areas in which the Spanish scientific community is strongest and help to identify future needs and developments.

Spanish National Research Frameworks

Spanish research has been funded by different Ministries: since April 2008 by the Ministry of Science and Innovation (Ministerio de Ciencia e Innovación, MICINN), from 2004 to 2008 by the Ministry of Education and Science (Ministerio de Educación y Ciencia, MEC), from 2000 to 2004 by the Ministry of Science and Technology (Ministerio de Ciencia y Tecnología, MCyT), and before this by the Interministerial Commission of Science and Technology (Comisión Interministerial de Ciencia y Tecnología, CICYT), through the National Plans of Research, Development and Technological Innovation (Planes Nacionales de Investigación, Desarrollo e Innovación, PN I+D+I). These plans lasted for four years with annual, competitive, public calls for project proposals which were peer-reviewed. The knowledge areas and the programmes addressing them were designed by the ministry according to the national priorities as well as the current topics addressed in the European Union Science and Technology Framework Programmes. The Marine Sciences used to be a part of the Natural Resources Science and Technology area, and first had a specific programme in 1995; thus, by 2007 three full periods had been completed.

The present review includes the Research and Development Projects that were funded by the Marine Sciences and Technology program (Programa de Ciencias y Tecnologías Marinas) for 2003 to 2007, the Marine Accidental Pollution program related to the strategic action for the Prestige oil tanker incident (2003-2004), marine polar research encompassing the Polar Year Initiative (2007-2008), and the marine projects related to biodiversity (2004-2007). The data used are from the public domain (http://www.micinn.es) and from data by the Sub-

TABLE 1. – Summary of the Spanish RTD 2003-2007 funded projects: Number (No.), total funds granted (€: euros), participation in person year $^{-1}$ (EDP) and mean values of funding and project EDP by research areas.

Area	Topic	No.	Grant	EDP Total	Mean grant	Mean EDP
Marine research and maritime transport	Fish – aquaculture	16	1978999 €	98.5	123687.44 €	6.16
	Marine Biotechnology	5	885720 €	36	177144.00 €	7.20
	Energy/wealth	0	0 €	0		
	Aggregate ore deposits	1	74970 €	5	74970.00 €	5.00
	Socio-economics of marine resources	0	0 €	0		
	Maritime transport	9	931745 €	52.5	103527.22 €	5.83
	Total area	**31**	**3871434 €**	**192.0**	**124884.97 €**	**6.19**
Coastal zones, shelf seas, continental margins and biodiversity	Coastal Zones and Marine Spatial Planning	12	1804816 €	83	150401.33 €	6.92
	Observing. predicting and monitoring systems	12	1391293 €	60.5	115941.08 €	5.04
	Ocean margin geologic processes and geohazards	9	1316279 €	77.5	146253.22 €	8.61
	Marine Biodiversity	6	865120 €	49	144186.67 €	8.17
	Functional role of biodiversity	10	1504468 €	53.5	150446.80 €	5.35
	Microbial diversity	8	1057950 €	35.5	132243.75 €	4.44
	Total area	**57**	**7939926 €**	**359.0**	**139296.95 €**	**6.30**
Ocean climate interactions and feedback	Climate Change	1	174966 €	5	174966.00 €	5.00
	Ocean-atmosphere coupling and the ocean thermohialine circulation	28	4107267 €	168	146688.11 €	6.00
	Ocean biogeochemical impacts and feedbacks in a greenhouse ocean	9	1873816 €	55.5	208201.78 €	6.17
	Ventilation of marine biogases and fertilisation feedbacks	0	0 €	0		
	Total area	**38**	**6156049 €**	**228.5**	**162001.29 €**	**6.01**
New frontiers in marine science	Life in extreme environments	1	109250 €	4	109250.00 €	4.00
	Deep-sea frontier	5	786923 €	49	157384.60 €	9.80
	Arctic seas – IPY	20	3866529 €	221	193326.46 €	11.05
	Total area	**26**	**4762702 €**	**274.0**	**183180.86 €**	**10.54**
Critical technologies	**Total area**	**4**	**779390 €**	**41.5**	**194847.50 €**	**10.38**
Marine pollution	**Total area**	**76**	**9618923 €**	**469.5**	**126564.78 €**	**6.18**
	TOTAL	**232**	**33128424 €**	**1564.5**		

Directorate General of Research Projects (Ministry of Science and Innovation).

The project information has been arranged according to the scientific targets identified by the MarinERA project from either the Navigating the Future Document, the Networks of Excellence (i.e. MarBEF, Eur-OCEANS), or the ESF-EUROCORES, SeaDataNet and EraNETs. Spanish projects corresponding to these areas were identified by the project title, key words and summary.

Participation by research areas

Seven main target areas were identified by MarinERA: 1) marine research and maritime transport, 2) Europe's coastal zones, shelf seas, continental margins and biodiversity, 3) ocean climate interactions and feedback, 4) new frontiers in marine science, 5) critical technologies, 6) research infrastructures, 7) multidisciplinary studies and the future European research strategy. Several categories are established within each area (Table 1). All areas were included in the analysis except for 'Research infrastructures' and 'Multidisciplinary studies and the future European research strategy' which correspond to different calls for research proposals issued by the ministry and operating at a different level. There are some difficulties involved in adapting the Spanish framework objectives to the areas, and in some cases they do not correspond, as in the topics without marine-related projects: energy or wealth; socio-economy of marine resources; ventilation of marine biogases and fertilisation feedbacks; multidisciplinary studies and the future European research strategy. The fisheries-aquaculture area only comprises projects related to the impact of fisheries, biology of target species, or relationships between marine resources and environmental variables. The aquaculture objectives for Spain aim to improve production and do not correspond to the topic definition of MarinERA. Therefore, aquaculture was not included in the analysis. An additional area related to Marine Pollution was included.

Table 1 summarises the topics with the number of projects by topic, the funds dedicated to the topic and the scientists implicated (in equivalent persons

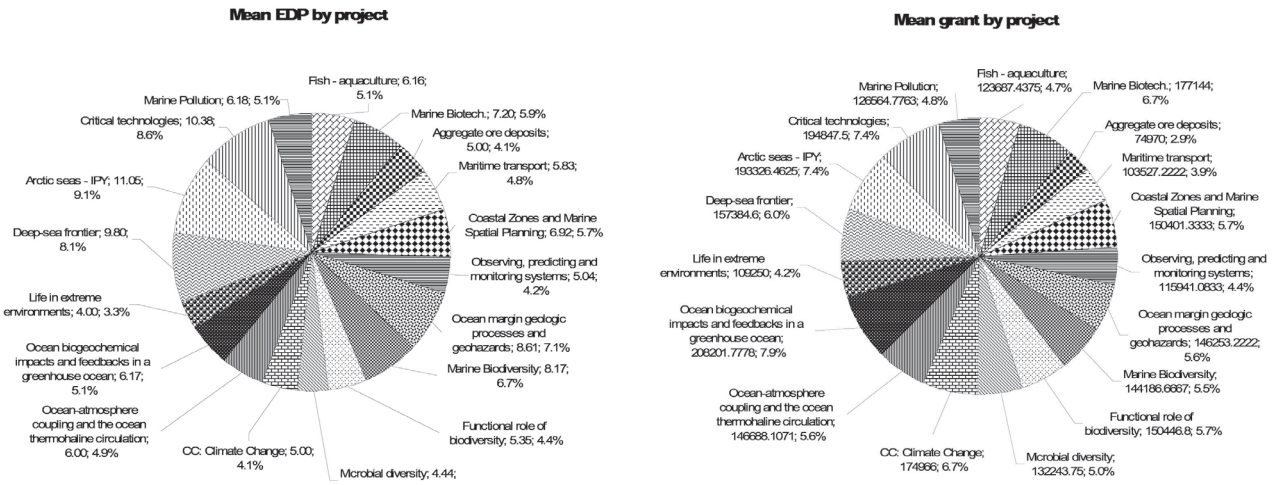

FIG. 1. – Participation and funding: mean persons year^{-1} (EDP) and grants for each topic in the framework of Spanish RTD funded projects from 2003 to 2007.[%: ratio *vs*. total].

per days, EDP). A total of 232 projects were funded, which corresponded to more than 33 million euros, with the participation of more than 1500 EDP (each researcher is able to participate in 2 projects with a shared dedication). The cost of research vessels is not included in the project grants.

The area with most participation in projects was 'Coastal zones, shelf seas, continental margins and biodiversity', followed by 'Ocean climate interactions and feedback', 'Marine research and maritime transport', 'New frontiers in marine science' and finally 'Critical technologies' (Table 1). Marine Pollution had a special call for project proposals, which resulted in 76 projects. The participation (Fig.1 upper chart) and the relative grants and funding (Fig. 1 lower chart) show very similar effort dedicated to each topic. When we compare the number of projects, investment and participation by project and topic, there is quite a uniform distribution (Fig. 1), which means that when we do not include the vessel costs, marine science projects have a similar cost irrespective of their objectives. The even distribution of participation and funding by topics (Fig. 1) shows that the Spanish scientific community has a wide range of interests and a similar capacity for obtaining funds, although there are some topics that are not covered (Table 1).

The response of the scientific community to special calls for project proposals like the ones related to the IPY-International Polar Year (N=20) and to the Prestige event (Albaiges *et al.*, 2006) (N=76) is noteworthy, with high investment in polar research and marine pollution respectively. This large response was probably due to the open participation

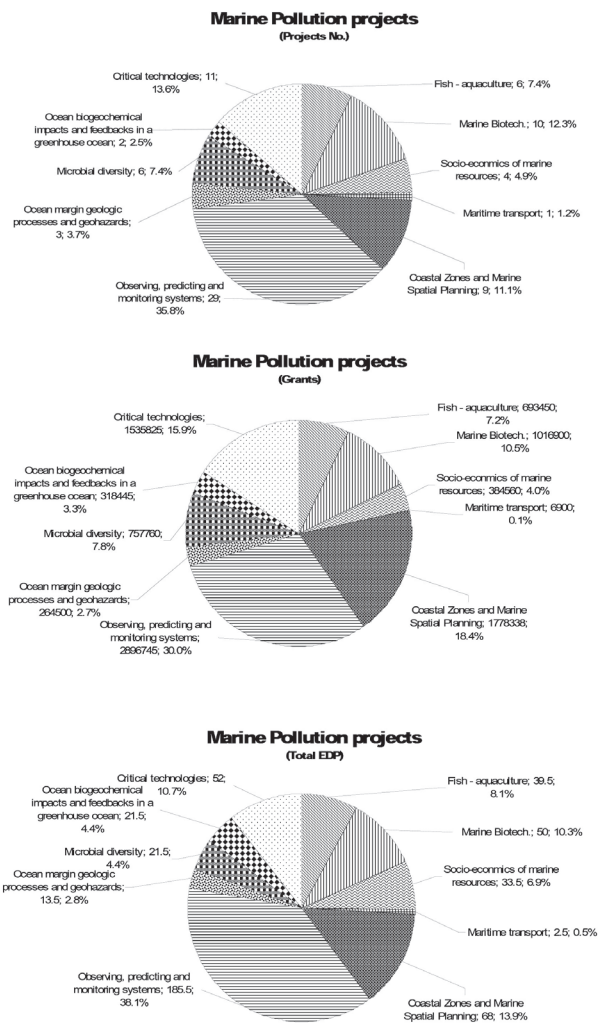

FIG. 2. – Classification by project number, grants and participation of the Marine Accidental Pollution projects in the framework of the Spanish RTD funding agency from 2003 to 2007. [%: ratio *vs*. total]

framework, as scientists were not limited to being active in only two living projects. The grant obtained by participation in each topic is presented in Figure 3, and shows quite uniform revenue according to dedication in most topics; the exceptions are climate change and thermohialine regulation which received more revenues (>8%).

The accidental marine pollution strategic call covered several topics: the main one was observing and predicting systems (operational oceanography) according to participation as well as funding granted (Fig. 2). Topics not covered in the general calls for project proposals, such as socio-economy, were present in this call due to the participation of research groups that normally do not work in marine science or who are funded by other agents or programs.

Marine research and oceanography are critically dependent on advanced technologies to observe and understand ocean ecosystem dynamics and processes. However, there were few technological projects although technological objectives were always included in the calls for research proposals. This may be due to technologists using other MEC RTD calls for project proposals in cooperation with the industry, although a screening of the PETRI (projects for the transference of technology to industry) research calls for 2005 and 2006 showed only four projects related to aquaculture enhancement and one to numerical models for marine pollution modelling trajectories inside a port.

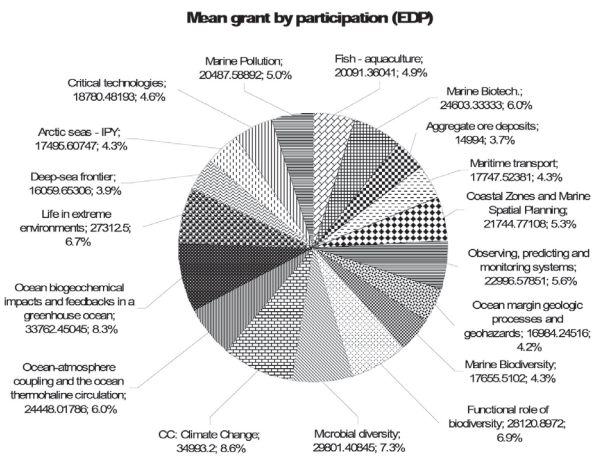

FIG. 3. – Mean grant by participation (EDP) by topic in the framework of the Spanish RTD funding agency from 2003 to 2007. [%: ratio *vs*. total]

DISCUSSION

Spain has a very large coastline (>6600 km) with 60% of the population living in coastal areas (source: Instituto Estadística España). The Spanish fishing fleet is the biggest fleet in the EU in terms of tonnage and constitutes 25% of the EU-25 total. Spain is the major contributor to EU aquaculture production. Spain is the overall leader in the total fish production in the EU with the majority of this production intended for human consumption. Spain is also one of the major shipbuilders in Europe. Moreover, coastal and marine tourism accounts for 53.5 million tourists (source: Institute Tourism Studies). Therefore, the main economic drivers in Spain are very related to marine and coastal sources. Moreover, there is still potential for development, for instance in offshore wind power production.

There are many challenges facing the Spanish scientific community: to support sustainable development of coastal and marine tourism, reduce the impact of climate change, promote management of maritime shared seas, and avoid pollution from ships (ESF-Marine Board, 2007). All of these require knowledge of how things 'work' in the oceans and how they interact. We must recognise the role of the oceans in our life-support system and their value for humankind. This requires excellent science, the technology for carrying it out, and support for individuals and governments (Independent World Commission of the Oceans, 1998).

Although this is a partial revision as other research funding sources have not been included (regionally funded projects and other ministry funded initiatives), it covers the main sources of competitive peer-reviewed research funding. The analysis shows that the research effort in the main challenging areas is somewhat limited; there are central areas in which the scientific marine community is not involved. A worrying issue is the low number of technological projects; which indicates a strong dependence on foreign products.

The tendency for marine science funding to increase, which was detected for 1995 to 2003 in the National Plans (Morales-Nin and Sánchez, 2004), has continued in the 2004 to 2007 period, which has increased due to strategic actions due to international actions (IPY) or ecological catastrophes (Prestige accident). The participation in funded marine science projects has also increased notably, from 550 persons year^{-1} (EDP) (1995-1999) to 780 persons year^{-1} (2000-2003) to 1500 persons year^{-1} (2003-2007). However,

the estimated pool of Spanish scientists, Ph students and technicians publishing in the marine sciences is around 21000 (Duarte *et al.*, 2006), which shows that the pool of scientists seeking competitive funds is rather reduced. Future studies should include a detailed revision of these data.

A main change that is already operating, is the bottom up approach in the new framework (2008-2011) that does not have defined objectives in the calls for research proposals. The scientists themselves have to identify a relevant research objective and structure the proposal accordingly. We will be able to see the changes and maybe the redefinition of the topics in the near future. However, in the current 2008 call, the proposals are following the same patterns as in previous research calls.

We believe, even without a direct economic evaluation, that the services and economic revenues related to coastal and marine areas are Spain's lifeblood as well as Europe's. Europe's maritime spaces and its coasts are central to its wellbeing and prosperity – they are Europe's trade routes, climate regulators, sources of food, energy and resources, and a favoured site for its citizens' residence and recreation. On the one hand, technology and know-how allow us to extract ever more value from the sea, and more and more people flow to Europe's coasts to benefit from this value. On the other hand, the cumulated effect of all this activity is leading to conflicts of use and to the deterioration of the marine environment that everything else depends on (EU, 2007).

Spain must address the challenges that are emerging due to the growing competing uses of the sea, which include maritime transport, fishing, aquaculture, leisure activities, off-shore energy production and other forms of seabed exploitation. By helping to develop a more sophisticated understanding of the impact of human activities on marine systems, scientific research and technology may provide the key to carrying out sea-based activities without degrading the environment, and to predicting and mitigating as much as possible the effects of climate change. Therefore, a clear strategy needs to be drawn up to link political and research priorities, dedicate more resources to marine science and stimulate the scientific community to face all these challenges which are very relevant for Spain.

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