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INTEGRATED MARITIME PLATFORM FOR REAL-TIME DISASTER RISK MANAGEMENT IN COASTAL AND PORT AREAS

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Abstract: The analysis of European bodies and agencies in the field of maritime safety management highlights the limited capacity to respond to potential disasters in the coastal and port areas of the Romanian state. Starting from this situation, the PLATMARISC project builds an intervention strategy based on an integrated risk management system that facilitates both multidisciplinary oceanographic research and monitoring and management of potential coastal and port disasters.
Keywords: port and coastal zone, research vessel, risk, oil spill, real-time monitoring.

1. Introduction

Coastal and port areas are areas where economic and social activities register very high values. As these areas are border areas where the transition from terrestrial to marine environment occurs, the diversity of flora and fauna individualized them both from this perspective and from that of environmental factors. In the case of Romania the coastal and port area is more densely populated than the hinterland area, on the territory of the coastal area concentrating a large number of economic activities but also important critical infrastructures. In this area there are water transport activities, sea and river, port operation activities of a large and diverse volume of goods, shipbuilding and repair activities and other industrial activities. To these are added human activities such as tourism and recreational sports and fishing.

It is unanimously accepted that the problem of disasters and implicitly their management is a matter of great topicality and of great interest to all interested factors: representatives of the economic environment, local communities, representatives of administrative and regulatory authorities.

In recent years, the issue of disasters has been restricted to the spread of diseases/ the phenomenon of pandemics or climate change. But let's not forget that the class of disasters also includes major technological accidents, which are divided into two classes: 1) industrial accidents (chemical spills, explosions and fires, leaks of gas, oil and other dangerous substances, radiation and others); 2) accidents associated with logistical activities associated with road, rail, naval and air transport modes.

The specialized literature shows that since 1900 technological disasters represent over 36% of all disasters present in the international databases, EM-DAT 2020. According to EM-DAT in the period

2000-2019 there were 5143 technological disasters of which approximately two thirds (3532 disasters) were reported as transport accidents [20].

As shown in EM-DAT, events such as the 2020 Beirut port explosion or the 2010 Deepwater Horizon oil spill are highlighted by their huge humanitarian, political, social and economic impact.

From this worldwide perspective, the continuous increase in the frequency of these accidents, the amplification of the manifestations and the severity of the associated consequences [21] can be seen.

All these aspects require a unitary approach to risks, with an emphasis on monitoring the sources of risk and on the activities of preparation, intervention and response in the event of an accident.

Under these conditions, the concept of disaster can be studied and analyzed as an emergency situation, for which risk reduction is achieved through: 1) risk management, with the related stages (identification, analysis and evaluation, treatment and monitoring); 2) disaster management, carried out in space and time after the disaster, from moment t_0 until the return to normality [20, 21].

In the area of the Romanian Black Sea coast, offshore activities of exploitation of marine resources have been registered for a long time, the growth perspective of which is certain, especially in the field of gas and oil exploitation.

As stated in the coastal area of the Black Sea are present living marine resources and highly productive ecosystems. Careful analysis carried out at regional level by the competent institutions shows that coastal and port areas are often vulnerable to natural and anthropogenic hazards. For these reasons, the development of forecasting and early warning systems is recommended for the permanent monitoring of these areas, which will ensure, in addition to the observation and evolution of risk factors, real-time intervention for disaster risk management in the affected areas. It is known that satellite remote sensing systems provide precious information and effective monitoring of the world's seas and oceans. Despite these advantages, in some cases satellite observations do not always meet the accuracy required by users. This was found in the case of marine accidents that had as an effect the marine pollution with hydrocarbons, especially the one manifested in the dynamic coastal and port areas, in which the evolution of the pollutant had greater variability.

The research aims to identify constructive and technological solutions in the form of integrated maritime platforms for real-time intervention for disaster risk management in coastal and port areas, maritime security and marine pollution with hydrocarbons and other hazardous substances. Such a solution would also ensure the permanent research of the maritime space, especially of the coastal areas from a multidisciplinary perspective: water quality and changes in marine ecology; physical characteristics (bathymetry, topography, vertical movement of the terrain); meteorological and oceanic variables (metocean), which can also act as force factors that can amplify coastal hazards.

The paper is organized in the following sections: literature review, the concept of integrated maritime platform, identification of the solution used in pollution risk management and its integration in the concept of integrated maritime platform, conclusions and future research directions.

The research was carried out within the project POC/163/1/3 120201 Innovative integrated maritime platform for real-time intervention through simulated assistance in disaster risk management in coastal and port areas - PLATMARISC.

2. Literature review

Forecasting and early warning of environmental conditions, as well as anticipation of emergencies, of maximum danger, such as hydrocarbon pollution, are essential activities in managing the risk of anthropogenic disasters in coastal and port areas. Forecasting and monitoring is expected to obtain the necessary information for the safe conduct of all activities that take place in the maritime area analyzed: shipping, port activities, offshore activities, etc. and the protection of vulnerable natural or human areas and objectives.

The western coast of the Black Sea has its own peculiarities, which are even more evident from February 2022. Therefore, to identify technical solutions that could be implemented for maritime space research, research teams must take into account both the limitations of the technical and financial order as well as the specific restrictions that appear or are maintained in the analyzed areas (such as the military

context existing at the Black Sea since February 2022). Considering this aspect, among the variants recommended by the specialized literature, two variants of maritime space research are highlighted: 1) a first solution in the form of complex coastal observation points located in the vicinity of the coastal area; 2) the second solution for multidisciplinary oceanographic research vessels.

For the first solution, the literature shows that in the last 20 years the coastal observation points are constantly evolving: in the USA and in Europe [1-4] in Asia and Australia [5-7], in South America [8-9].

Regarding this solution locally in the western part of the Black Sea, the MarineGeohazard project was developed, the result of which is the Euxinus system that ensures monitoring and alerting to natural hazards [10]. The Euxinus system is composed of:

1) Euxinus network consisting of 3 marine monitoring stations. The observation systems and equipment are located on three complex beacons (EuxRO 1, EuxRO 2 and EuxRO 3) are located offshore, approximately 160 km from the coast, in the area of the continental plateau of Romania. The network is completed with a coastal station located near the port of Mangalia.

2) The National Monitoring Center - Natural Hazard Alarm Marine Euxinus which can store and process the information that is obtained from the network of equipment in the Black Sea Security System. In the case of this solution, the information is used in an integrated way within a real-time warning system for the occurrence of marine hazards in the western part of the Black Sea coast in the Romanian-Bulgarian cross-border area.

The center benefits from the results obtained in the coastal area of Bulgaria, which has a similar center in Varna, between the two centers there is a permanent exchange of information that ensures the obtaining of useful forecasts [11-12].

Figure 1. Eurofleets consortium - existing research vessels at regional level (https://www.eurofleets.eu/)

The second solution proposes the use of multidisciplinary oceanographic research vessels. It is known that there are a number of international research vessel associations worldwide: EERIS, ERVO, EUROCEAN and at European level the EUROFLEETS consortium, figure 1.

Literature review [13-15] shows that these ships have an important role in scientific research and development in the fields: biology and marine ecology, physical oceanography, study and analysis of mineral and energetic substances, impact studies on the marine environment, including environmental assessments, etc. If necessary, these vessels may carry out logistical support operations for the maintenance of marine systems. Starting from these aspects, table 1 presents the main technical characteristics of these ships.

The information identified from the consulted bibliographic sources led to a first concept of such a ship, figure 2.

In 2022, Romania owns the oceanographic ship Mare Nigrum, which was built in 1971, being integrated in the Eurofleets consortium [14]. Mare Nigrum is a ship that can carry out multidisciplinary research activities, which belongs to the National Marine Alarm Monitoring Center for Natural Hazards Euxinus [16]. The ship carries out activities in the field of marine biology and ecology but also of geology and geophysics and has the necessary facilities for carrying out research activities: deck naval systems (crane, folding portal, specialized winches).

The main deck in the stern of the ship has a large surface area that can be used for research operations. The ship has the following equipment:

- research equipment incorporated in the structure of the ship: multibeam bathymetric system, seismic-acoustic system, magnetometer for the marine environment, gravimetry systems, systems that provide gas measurements, ROV (1000m depth), etc.
- water and sediment measurement and sampling equipment.
- naval deck systems ensuring the launch of equipment: winches (20 and 8 tf), CTD winches, 2 naval beams (1.8 tf) and a hydraulic crane (3 t).

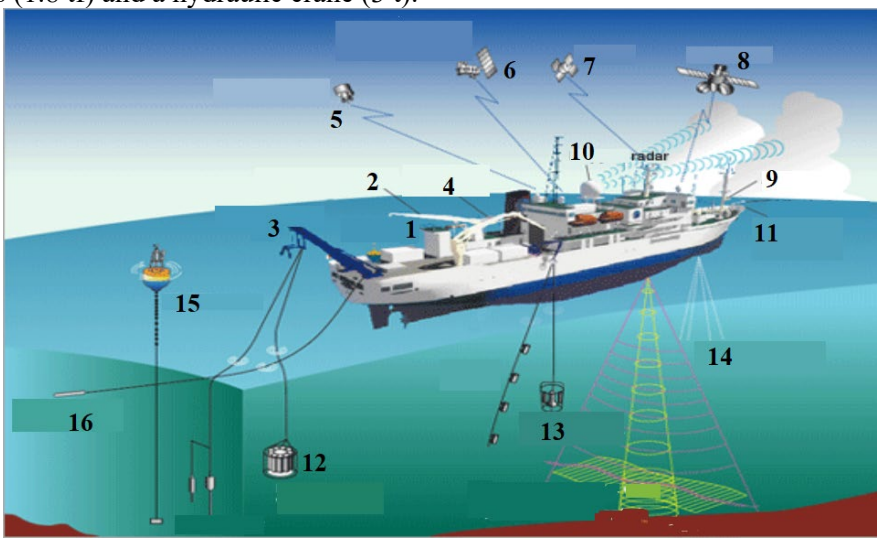


Figure 2. Multidisciplinary oceanographic research vessel - preliminary concept

1- Container Laboratory; 2- On-board hydraulic crane; 3 - Frame crane in the stern area; 4 - Naval beam system; 5 - Meteorological Satellite (GMS); 6 - Meteorological Satellite (NOOA); 7- GPS; 8 - INMARSAT system; 9 - Air emissions; 10 - Radar system; 11 - Dynamic wave height measurement system; 12, 13 - Carousel system for taking samples for chemical analysis and ecotoxicology of water; 14 - Seismic-acoustic system; 15 - Beacon for observing the marine environment; 16 - Magnetometer for the marine environment.

As stated for the activities carried out in the maritime space, the threats on the environment are diverse, both from the perspective of risk-generating sources and from the perspective of their magnitude and impact [19].

Table 1. European research vessel fleet (2019)

Country	Name	Class	Lenght (m)	Year built	Name of operator	Country	Name	Class	Lenght (m)	Year built	Name of operator
Belgium	Belgica	Regional	50.90	1984	RBINS.OD Nature	Norway	Dr Fridtjof Nansen	Global	74.50	2016	IMR
	Simon Stevin	Coastal	36.00	2012	VLIZ		G.M.Dan Nevig	Regional	27.80	1979	IMR
Bulgaria	Akademik	Regional	55.50	1979	IO-BAS		G.O. SARS	Global	77.50	2003	IMR
Croatia	BIOS OVA	Regional	36.80	2009	IZOR		Gun Nerus	Regional	31.00	2006	NTNU
	Hidra	Coastal	22.10	1993	HHI		Hans Brattstrom	Coastal	24.30	1992	IMR
	Nase More	Regional	3135	1991	University of Dubrovnik		Helmer Hanssen	Ocean	63.80	1988	UIT
	Vila Velibita	Coastal	25.50	1948	Ruder Boskovic Institute		Johan Hjort	Ocean	64.40	1990	IMR
Denmark	Aurora	Coastal	28.00	2014	Aarhus University		Kristine Bonnevie	Ocean	56.75	1993	IMR
	Dana	Ocean	78.43	1981	DTU AQUA		Kronprince Haakon	Global	100.00	2017	IMR
	Havfisken	Coastal	17.18	2015	DTI-J AQUA		Seisma	Local	16.80	1985	NGU
Estonia	Salme	Regional	31.40	1974			Trygve Braarud	Coastal	21.80	1983	UIO
Faroe Islands	Magnus Heinason	Regional	44.50	1978	FAMRI	Poland	Baltica	Regional	41.00	1993	NFMRI / IMGW
Finland	Aranda	Ocean	66.30	1989	SYKE		Imor	Regional	32.50	2006	Maritime Institute in Gdansk
France	Alis	Coastal	28.40	1987	French Oceanographic Fleet		Oceanograf 2	Regional	49.50	2016	University of Gdansk
	Antéa	Regional		1995			Oceania	Regional	48.50	1985	IO-PAN
	Beautemps-Beaupré	Ocean	80.64	2002	French Navy	Portugal	Arguipelago	Coastal	25.00	1993	University of Azores
	Cotes de la Manche	Coastal	24.90	1997	French Oceanographic Fleet		Mar Portugal	Ocean	75.60	1986	IPMA
	L'Atalante	Global	84.60	1990			Noruega	Regional	47.50	1978	IPMA
	L'Europe	Coastal	29.60	1993			NRP Almirante Gago Coutinho	Regional	68.30	1985	Portuguese Navy / HI
	Marion Dufresne	Global	120.50	1995			NRP Andromeda	Coastal	31.40	1985	
	Pourquoi pas?	Global	107.70	2005			NRP Auriga	Coastal	31.40	1987	
	Thalassa	Ocean	74.50	1996			NRP Don Carlos I	Regional	68.30	1989	
	Thalia	Coastal	24.50	1978		Romania	Istros	Local	31.86	1986	GeoEcoMar
	Thetys II	Coastal	2480	1993			Mare Nigrum	Regional	82.00	1971	GeoEcoMar
Germany	Alkor	Regional	54.90	1990	GEOMAR	Spain	Angeles Alvari No	Regional	46.70	2012	IEO
	Elisabeth Mann Borgese	Regional	56.50	1987	IOW		Francisco de Paula Navarro	Coastal	30.46	1987	IEO
	Heincke	Regional	55.00	1990	AWI		Garcia del Cid	Regional	37.30	1979	CSIC
	Littorina	Coastal	29.80	1975	Kiel University / GEOMAR		Hesperides	Global	82.50	1990	Spanish Navy / CSIC
	Ludwing Prandtl	Coastal	32.50	1983	Helmholtz Centre		Ramon Margalef	Regional	46.70	2011	IEO

Country	Name	Class	Lenght (m)	Year built	Name of operator	Country	Name	Class	Lenght (m)	Year built	Name of operator
	Maria S. Merian	Global	94.76	2006	LDF		Sarmiento de Gamboa	Ocean	70.50	2007	CSIC
	Meteor	Global	97.50	1985/86	LDF		SOCIP	Coastal	23.76	2012	SOCIB
	Polarstern	Global	117.91	1982	AWI		UCADIZ	Coastal	25.00	2016	UCA
	Poseidon	Regional	60.80	1976	GEOMAR		Electra	Coastal	24.30	2016	Stockholm University
	Senckenberg	Coastal	29.71	1976	Senckenberg I nstitut		New Skagrak	Regional	49.00	2017	UoG
	Sonne Il	Global	118.42	2014	ICBM	Sweden	Ocean Surveyor	Regional	38.00	1984	SGU
Greece	Aegaeo	Regional	6151	1985	HCMR		Oden	Global	108.00	1988	SMA
	Philia	Coastal	26.10	1986	HCMR		Svea	Ocean	69.50	2019	SLU
Greenland	Sanna	Coastal	3230	2015	CINR		Bilim II	Regional	40.70	1983	METU-IMS
Iceland	Arni Fridriksson	Regional	70.00	2000	MFRI		Seydi Ali Reis	Coastal	22.50	2012	Sinop University
	Bjarni Saemundsson	Regional	56.00	1970	MFRI	Türkiye	TUBITAK Marmara	Regional	41.20	2013	TUBITAK
Ireland	Celtic Explorer	Ocean	65.50	2003	Ml		Yunuz	Regional	32.00	1994	Istanbul University
	Celtic Voyager	Regional	31.40	1997			Alba Na Mara	Coastal	27.00	2008	Marine Scotland
Italy	CRV Leonardo	Coastal	28.60	2002	NATO CMRE		Cefas Ende Avour	Ocean	73.00	2003	Cefas
	Dallaporta	Regional	35.30	2001	CNR		Corystes	Regional	52.25	1988	AFBI
	Laura Bassi	Global	80.00	1995	OCS		Discovery	Global	99.70	2013	NMF
	NRV Alliance	Global	93.00	1988	NATO CMRE		James Cook	Global	89.50	2006	NMF
	OCS Explora	Global	65.40	1973	OCS	United Kindom	Prince Madog	Coastal	34.90	2001	Bangor University / P&O Maritime Services
Lithuania	Mintis	Regional	39.20	2014	Klaipeda University		Sir David Attenborough	Global	128.00	2019	BAS
Netherlands	Pelagia	Ocean	66.00	1991	NIOZ		Sir John Murray	Coastal	23.90	2004	SEPA
							Scotia	Ocean	68.60	1998	Marine Scotland

Among the vulnerabilities present in the Romanian maritime space is also marine pollution with hydrocarbons or other dangerous substances / goods, events that are identified as important threats for the entire maritime sector.

The need to develop and implement an "Integrated Maritime Platform for real-time intervention through simulated assistance in disaster risk management in coastal and port areas" also results from the analyzes of the European Maritime Safety Agency (EMSA) for Romania, [17-18].

EMSA emphasizes that such an objective would help reduce the risk of loss of life, pollution, risk of destruction of infrastructure and equipment belonging to economic operators. At the same time, EMSA notes the limited capacity to respond to potential disasters in the coastal and port areas of the Romanian state. Given the foreshadowing of the increase in oil and gas resources in the central west of the Black Sea, activities that add to the existing ones such a project is necessary.

The analysis performed in this section of the paper shows that the two variants of research, monitoring and response of the maritime space, located in the coastal area of Romania are limited. These solutions do not have facilities for monitoring and managing marine oil pollution or for real-time intervention. Starting from this situation, the PLATMARISC project aims to build an intervention strategy based on an integrated risk management system that facilitates both multidisciplinary oceanographic research and monitoring and management of potential coastal and port disasters.

In these conditions at this moment there are two variants of research of the maritime space, all in the coastal area of Romania are limited. These solutions do not have facilities for monitoring and managing a marine oil pollution, respectively for real-time intervention for disaster risk management in coastal and port areas.

Starting from this situation, the PLATMARISC project aims to build an intervention strategy based on an integrated risk management system that facilitates both multidisciplinary oceanographic research and monitoring and management of potential coastal and port disasters.

3. Integrated maritime platform for real-time disaster risk management in coastal and port areas - the PLATMARISC concept

As can be seen from the concept diagram in figure 3 within the existing partnership in the PLATMARISC project, the COREMAR research unit and the “Mircea cel Bătrân” Naval Academy (MBNA) will integrate the existing systems and equipment with those purchased within the project.

In turn, the integrated maritime platform is a technological platform for marine research, which has the following dimensions: length: 28 m, width 10 m, depth on the sides 4.05 m and the depth required for floating / navigation is 4.01 m. From a functional point of view, the platform will integrate the equipment represented in figure 4.

In the case of the marine research technology platform, the electricity supply will be provided by means of an electric generator in the standard equipment of the platform. According to the technical data, the fuel consumption is 200 kg/h of operation. At the same time, the Platmarisc platform will be equipped with special tanks with a capacity of 14.5-15 m^3 (fresh water), sanitary drainage tank (8.5-9 m^3), bilge water tank 5-5.5 m^3. The Platmarisc platform will be connected to the existing GSM WiFi data transfer network in the area of Port Constanta Sud (Agigea).

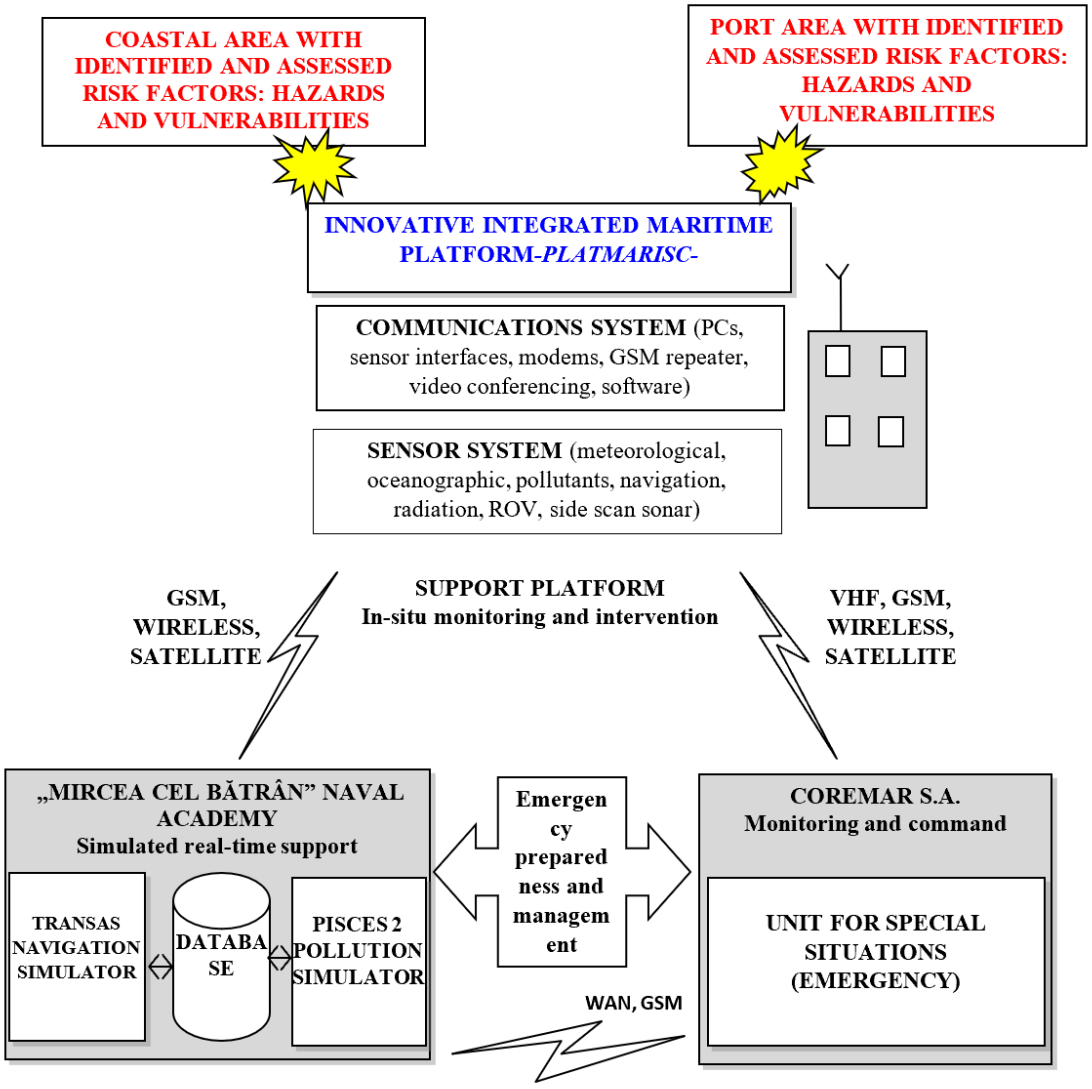
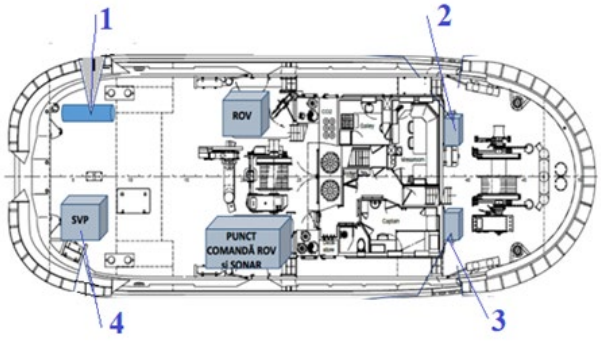
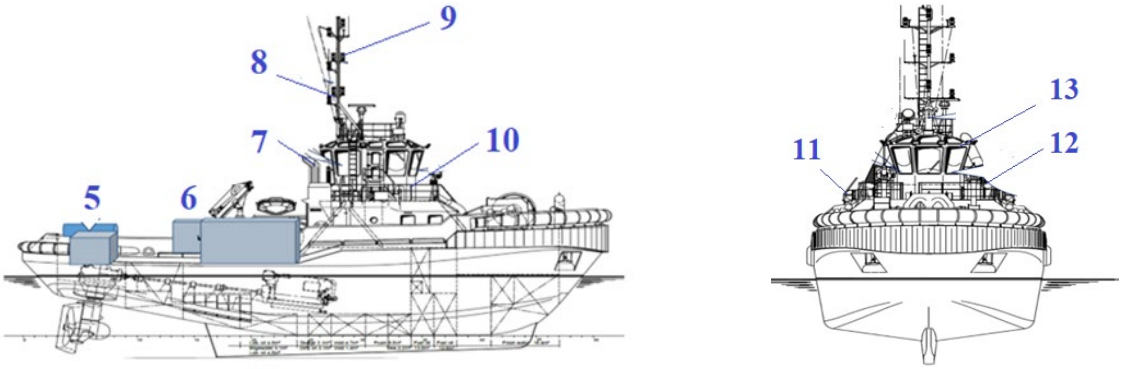


Figure 3 General plan of the technological data flow of the Platmarisc project



a)



b) c)

Figure 4. Schematic diagram for placing the equipment on board the support platform

a) Main deck section: 1 - Side Scanner Sonar sensor; 2 - Mobile chemical oceanography laboratory equipment (UV VIS specto-photometer, fluorimeter, refractometer, turbidimeter, trinocular microscope, glassware, etc.); 3 - Alpha, beta, gamma radiation detector and water hydrocarbon analyzer; 4 - Sound Velocity Profiler. b) Side view: 5 - Side Scanner Sonar / Sound Velocity Profiler sensor; 6 - e. Remote controlled platform for underwater inspections of type ROV (Remotely Operated Vehicle) and sonar; 7 - Terminals communication equipment (4G GSM repeater, wireless communication system, satellite communication system); 8 - Naval weather station sensors; 9 - Antennas communication equipment (GSM 4G repeater, wireless communication system, satellite communication system); 10 - Weather station terminal. c) Front view: 11- Video surveillance system / Laptop videoconference and viewing simulated scenarios; 12 - GDPS Terminal / Weather Station Terminal / Routers / 4G Modems; 13 - Speed 360-degree outdoor doom camera / DGPS antenna.

4. Conclusions. Future directions of research.

The research highlighted that the PLATMARISC project aims to build an intervention strategy based on an integrated risk management system that facilitates both multidisciplinary oceanographic research and monitoring and management of potential coastal and port disasters. Practice shows that there is a common interest in disaster risk management in ensuring a rapid connection between an innovative maritime platform for real-time intervention through simulated assistance and stakeholders.

Future research directions will be oriented towards the identification, acquisition and implementation of systems and equipment within the integrated platform.

Particular emphasis will be placed on the module for simulation of pollution scenarios with hydrocarbons and other hazardous substances. The research will focus on identifying appropriate solutions to pollution interventions, multi-criteria, effective in relation to pollution limitation, response time, and quick access to the site of the pollution incident. The results of the research will be used to develop plans to prevent, limit and combat pollution, in the case of simulating complex pollution accidents (offshore and onshore) caused by various stationary or fixed pollution sources.

The research team will consider that the results can be capitalized during the preparation process and training based on scenarios in order to train and improve human resources in the field of intervention in case of pollution incidents, including in the field of continuous training through management-specific training programs in crises (marine pollution, inland waterway pollution, etc.).

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