The ARGO Project: assessing NA-TECH risks on off-shore oil platforms

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amra
analysis and monitoring of environmental risk

DGS-UNMIG
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National Mining Office for Hydrocarbons and Georesources

THE KNOW HOW FOR THE OFFSHORE SAFETY

Within the framework of DGS UNMIG's collaborations on the offshore safety related to mining and energy activities, AMRA has made available its expertise regarding the possibility of developing a quantitative approach for **multi-risk assessments**. This through the analysis of a wide range of risk sources (Fig. 1). This method, taking into account possible scenarios of interaction and the cascading effects of accidents, ensure the possibility to define in terms of probabilities, the expected hazard. The multi-risks approach was developed within the **ARGO project** (**Analysis of natural and anthropogenic risks of offshore platforms**) with a case study in the offshore of the Adriatic Sea, thanks to the collaboration of Edison S.p.A., which provided the essential data for carrying out of the study. The work, described in the following sections, led to the formulation of a set of recommendations to ensure an appropriate monitoring useful to the definition of risks analysis for the **offshore platforms**.

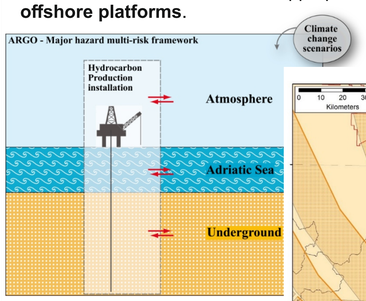
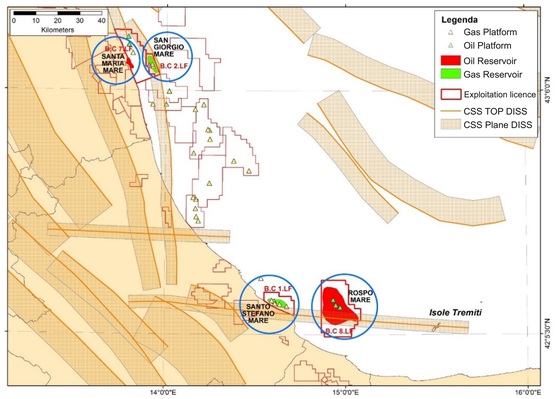


Figure 1 – Identification of possible environments where triggering sequences of events that can lead to accidents on offshore platforms can occur.

Figure 2 – The ARGO Project case studies.



ACTIVITIES AND RESULTS

The ARGO Project had two main objectives:

1.Development of methodologies for the analysis of natural and anthropogenic risks in the sector of protection and safety of oil and gas offshore platforms;

2.Provide technical support for the elaboration of recommendations resulting from the analysis of the project.

The case studies identified to carry out the project activities have focused on three areas of the Adriatic Sea (Fig. 2): **two gas extraction sites** (San Giorgio Mare and Santo Stefano Mare) and **one oil extraction site** (Rospo Mare). Within the ARGO Project was also carried out an assessment of the environmental effects of the **re-injection** at the **site** of the Santa Maria Mare.

The work initially focused on the definition of the case studies and on the identification of the necessary data for analysis, with particular reference to: meteo-marine data, atmospheric-circulation model, operational characteristics of the platforms and production data, historical offshore accidents documentation, geological and structural data, seismic lines, reservoir characteristics, images from remote sensors. The following phase consisted in the collection of all the kind of data available for the study area at the archive of the DGS UNMIG and available from scientific and technical literature. Finally, specific methodologies of work for each aims of the project have been developed.

In order to achieve these objectives, **the project activities were divided into six macro-activities**, for each of which the main results are illustrated in the following box.

Triggered/Induced seismicity analysis.

The activity has involved the analysis of confidential data, seismic reflection profiles and well data, granted by Edison S.p.A. in order to carry out the geological-structural characterization and seismotectonic of the study area. In parallel, was carried out the study of historical seismicity (1000-1980), and of instrumental seismicity (since 1980 to present) (Fig. 4) by using data of the INGV (CPTI and ISIDe database).

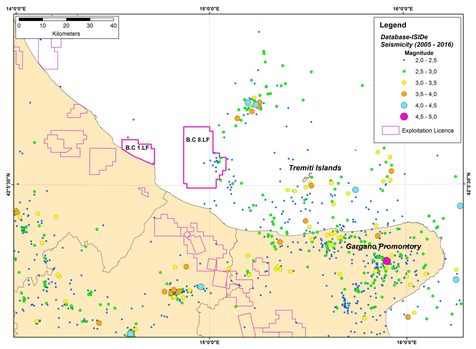


Figure 4 – Instrumental seismicity (2005-2016) of the study area.

Coastline evolution analysis near the offshore platforms.

The activity has involved the analysis of possible deformation of the coastline in front of the studied offshore platforms by using DInSAR. In particular, the activities were focused on the evaluation and analysis of deformation through the SBAS-DInSAR of images acquired by Envisat satellite in the period 2002-2010 from ascending orbit, producing velocity maps and deformation time-series.

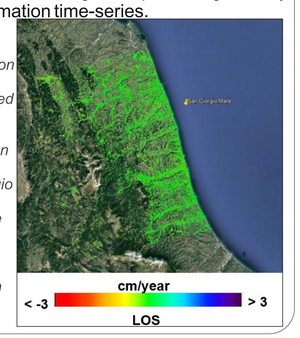


Figure 5 – Geocoded Map of average deformation velocity in LOS (cm/year), estimated at low spatial resolution and superimposed to an image of Google Earth of San Giorgio Mare area. The image refers to the elaboration of ENVISAT data acquired from ascending orbits in the period 2002-2010.

Environmental impact studies of industrial accidents in offshore platforms.

The study focused on the collection and analysis of the main methods used by public authorities, by non-governmental organizations, and trade associations operating in the main western countries, for purposes of monitoring, analysis and assessment of accident risks arising from mining activities, with particular reference to releases of hazardous substances from offshore platforms.

The comparison between the different evaluation impact models is a prerequisite to building a methodology for the Italian case, starting from a database of environmental impacts and major accidents occurred on the oil & gas platforms and to the definition of studied asset danger level. We summarize the methods produced by the: International Association of Oil & Gas Producers (OGP), the American Petroleum Institute (API), the Det Norske Veritas (DNV), the Health & Safety Executive (HSE) and by the Norwegian Petroleum Safety Agency (PSA).

The analysis of the WOAD database (World Offshore Accident Dataset) has made possible the study of offshore accidents occurred at global and national levels. The WOAD database data on Natech accidents on oil & gas platforms were reorganized in terms of KPI according to the HSE scheme, chosen as analysis system. The result obtained refers just to the scenarios described, to define the level of release (whether gas oil), and then the corresponding value of the KPI.

Determination of risk related to meteo-marine extreme events, considering the effects of climate change scenarios.

The aim of this activity was to characterize the study area from the meteo-marine point of view, through the analysis of several parameters (sea level, atmospheric pressure, temperature of the sea and air, relative humidity, wind speed), from historical to instrumental data.

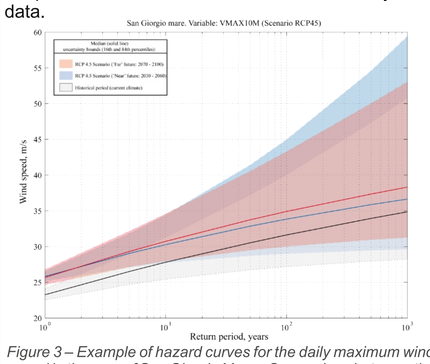


Figure 3 – Example of hazard curves for the daily maximum wind speed in the area of San Giorgio Mare. Comparison between the historical reference time and projection, considering the RCP4.5 scenario.

It was subsequently carried out the correlation analysis between the meteo-marine instrumental data and the atmospheric model data (RCM); this analysis showed significant correlations between instrumental and model data for the parameter "air temperature" in all study areas. Sufficiently high correlations are also highlighted for the maximum wind speed.Finally, was performed the analysis for the extreme events for different scenarios of climate change (RCP scenarios - Representative Concentration Pathways of the IPCC RCP4.5 and RCP8.5) in order to identify possible anomalies for the local climate, with particular attention to "maximum wind velocity" (Fig. 3) and "daily accumulated rainfall".

Assessment of systemic vulnerabilities and of the main structural elements of the offshore platforms to meteo-marine event.

The objective of this activity was to characterize the vulnerability of the offshore platforms with respect to the occurrence of meteo-marine extreme events through the use of fragility curves (for types of platforms) that provide the probability of exceeding a certain threshold of damage, conditioned by an intensity parameter suitably selected.

For this purpose, the different type of offshore production platforms (Fig. 4) and the structural elements that characterize it were defined.

It was carried out the literature analysis to describe the damage observed in past, caused by extreme meteo-marine events and have been described all the data collected in order to assess the vulnerability of the studied oil platforms. After many industrial accidents involving offshore oil platforms caused by extreme weather events occurred in the last years, it has been necessary a detailed study of incidental dynamics in the areas affected by oil production activities.

The study also included a data collection phase on the structural characteristics and layout of all the sensitive plants present on the studied platforms, with particular attention to the Santo Stefano Mare platform.

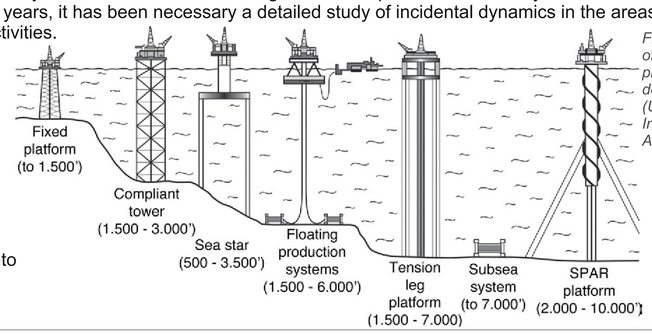


Figure 4– Type of offshore platforms and depth (feet) (US Energy Information Admnistration).

Implementing multihazard and multi-risk models for the integral evaluation of NATECH risks on offshore platforms.

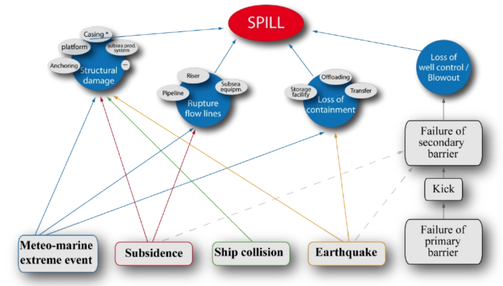


Figure 6 – Example of scenarios of events that can lead to hydrocarbon leak/spill.

AMRA in the frame of this activity has developed a multi-hazard/risk methodology based on the bow-tie approach and Bayesian techniques for data analysis. Thanks to this method, it is possible to analyze the probability of accidents occurrence on offshore platforms and their potential impact, taking into account uncertainties, and considering a wide range of natural and anthropic events. The methodology was applied to some of the platforms of San Giorgio Mare field in order to assess the probability of gas spill considering 9 different paths used events tree (Fig. 6).

CONCLUSION

The final analysis of the ARGO Project has led to the expression of a series of recommendations, among which one of the most significant involved a constant monitoring of exploitation activity, re-injection and storage through the use of high technology networks. Such networks should be designed to follow the evolution in space and time of microseismic activity, of soil deformation, of the pore pressure and of major meteo-marine parameters. Such networks should be operated before launching new activities, in order to evaluate the natural seismicity conditions, of ground deformation, of meteo-marine parameters and of downhole pressures in "unperturbed" conditions.

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