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Challenges in Harmonized Environmental Impact Assessment (EIA), Monitoring and Decommissioning Procedures of Offshore Platforms in Adriatic-Ionian (ADRION) Region

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Abstract: A harmonized and integrated approach for monitoring and assessment of contamination, including hydrocarbon exploitation one, is required both by Marine Strategy Framework Directive (MSFD) at EU level and by the Ecosystem Approach (EcAp) program of the Barcelona Convention at Mediterranean level. A broad review of protocols of environmental impact assessment (EIA) procedures, monitoring and decommissioning of offshore platforms adopted by EU and non-EU countries along the Adriatic-Ionian seas was carried out in the framework of the Interreg offshore platforms in Adriatic-Ionian (ADRION) project HarmoNIA (*Harmonization* and *networking for contaminant assessment in the Ionian* and *Adriatic Seas*). The comparison of information provided by six ADRION countries and the application of a harmonized and integrated approach has highlighted specific challenges for managing offshore platform impacts emerged at ADRION level: (i) need of the same legislative level (the Offshore Protocol of Barcelona Convention is not ratified by all countries); (ii) set up of a task force of ADRION experts for discussing critical issues related to impacts of offshore platforms; (iii) harmonization, at the regional level, of EIA procedures, monitoring and decommissioning; (iv) need of an agreed and common list of recommended parameters to monitor in water, sediment and biota for the assessment of impacts due to platform installations and PFW discharges.

Keywords: harmonized protocols; environmental impact assessment; monitoring; decommissioning; offshore platforms; Adriatic-Ionian Sea region; MSFD; Barcelona Convention

1. Introduction

Shipping, mariculture, offshore oil and gas extraction, marine renewable energy equipment, seabed reclamation, sediment dredging, dumping of dredged material and historical dumping are the main specific sea-based sources responsible for the release of chemical substances into the marine environment [1]. Such activities may jeopardize the achievement and maintenance of Good Environmental Status (GES) defined within Marine Strategy Framework Directive (MSFD), which is considered an essential objective for the environmental sustainability of marine socioeconomic activities and the protection of human health.

Tornero & Hanke (2016) [1], in their comprehensive report, have listed 276 chemical substances that may be released from sea-based sources into the marine environment.

Within this list, offshore oil/gas activities are regarded as potential sources of the highest percentage (36%) in terms of number of substances. Approximately 0.4% of the world's oil and gas reserves are located in the Mediterranean, which is therefore one of the areas where offshore activities will increase more strongly in the coming years [2].

In addition, the Adriatic-Ionian region (ADRION region) is characterized, beyond offshore hydrocarbon production, by a strong development in terms of urban expansion in coastal and inland areas and increasing maritime traffic. Furthermore, there are 148 oil and gas platforms in operation for hydrocarbon exploitation: 125 platforms on the Italian seabed, 20 on the Croatian seabed and three active licenses on the Greek seabed (no platforms in the Ionian sector yet). Slovenia and Montenegro, on the other hand, have no offshore platforms (Figure 1).

Figure 1. Location of 148 operating oil and gas platforms for exploitation of hydrocarbons in the Adriatic-Ionian (ADRION) area (HarmoNIA GeoPortal, Source: EMODnet Human Activities).

Offshore activities involve different phases linked to the exploitation of gas and oil reservoirs. (a) an exploration phase to probe the position and the geological characteristics of well; (b) installation of a steel platform; (c) a production phase to extract oil and gas; (d) a decommissioning phase, when the commercial life of all wells belonging to the platform is finished [3].

With regards to the aquatic environment, the most critical issues are due to the presence itself of the offshore structures and to the main waste stream represented by produced formation water (PFW) [4–17]. First, the offshore structures may cause both physical impact on marine ecosystem as well as chemical one by releasing contaminants to prevent corrosion (e.g., zinc and cadmium that are in sacrificial anodes of the structure). Second, PFW includes naturally occurring water in oil and gas reservoir, water injected into the reservoirs to help force the oil to the surface and production chemicals. As a consequence, different contaminants may be released in the environment: inorganic compounds (i.e., trace metals), volatile aromatic compounds (benzene, toluene, ethylbenzene, xylenes), semivolatile substances (i.e., naphthalene, phenanthrene, dibenzothiophene), phenols, organic acids and additives [18]. Both the positioning of a permanent structure and the PFW discharge, may modify the environmental quality by changing the physical–chemical characteristics of the water column and sediments and also by causing alterations of the marine living communities [19].

The oil and gas pollution is therefore a key issue for the ADRION area, which is also a hot spot for biodiversity, natural habitats and communities of great environmental importance. Common strategies towards environmental impact assessment and good environmental status are recommended among countries sharing a marine region or subregion. Transnational-shared approaches need to evaluate the impact of offshore activities by harmonizing environmental impact assessment (EIA), monitoring plans and decommissioning procedures. The EIA procedure includes site selection survey, baseline environmental characterization, project impact on the environment, environmental impact assessment, mitigation measures and environmental management plan [20]. Given the current (international and national) environmental regulatory provisions, the application of environmental monitoring tools is mandatory to study the natural features of the marine environment and the changes due to the presence of the offshore structures [21].

Once oil or gas fields reach the end of their operating life, which typically occurs between 10 and 30 years from the beginning of the production phase, the issue of decommissioning (essentially a restoration process) arises with the removal and disposal of a considerable quantity of raw materials, together with the problems related to environmental remediation and requalification. The offshore oil and gas industry is facing the prospect of decommissioning thousands of installations in the coming decades. Nowadays, there are many different regulatory approaches around the world for decommissioning operations, but there is no clear consensus on what should be regarded as best practices. The Oslo and Paris Commission's decision 98/3 [22] prohibits the dumping of whole offshore structures or parts of them and states that reuse, recycling or disposal on land are the preferred options. Dumping encompasses structures that may be left in place after their commercial life is over [23]. In order to protect the marine environment, it is coming to evidence that offshore structures themselves become part of the ecology of the system, utilized by marine biota and providing useful ecosystem function and services and habitat diversity [23–28]. Therefore, the decommissioning of offshore structures requires an evaluation at the ecosystem level and the implications should be acknowledged both locally as well as in the wider context of the regional seas.

With the aim to share best practices to evaluate potential offshore impacts, an extensive review of procedures adopted by EU and non-EU countries along the Adriatic-Ionian seas was carried out in the framework of the Interreg Adrion project HarmoNIA (Harmonization and networking for contaminant assessment in the Ionian and Adriatic Seas). The comparison of information provided by HarmoNIA laboratories on six ADRION countries has highlighted the need for harmonization of protocols for assessing impacts of offshore platforms on marine ecosystem. In this study, we describe a methodological proposal to reach a harmonized implementation of procedures of assessment, monitoring and decommissioning of offshore impacts.

2. Study Area and Information Collection

The Adriatic-Ionian Sea Region is a functional area primarily defined physically by the Adriatic and Ionian Seas basins. Covering also an important terrestrial surface area, the marine, coastal and terrestrial areas are considered in this context as interconnected systems. It has a strategic geographical position, being located on the intersection of main ways for transports between Mediterranean, Eastern Europe and Asia [29].

The Adriatic and Ionian Seas are crucial for the blue growth for both EU and non-EU coastal countries, although all the Adriatic-Ionian basin suffers from pollution of marine and coastal environment. Increased human use of the marine and coastal space may threaten marine ecosystems through several kinds of physical, chemical and biologic disturbances including contamination caused by hazardous substances. In particular, the overall increase in maritime transport, the increasing coastal urbanization and the foreseen increase in offshore oil and gas extraction in the ADRION region pose severe risks of pollution from hazardous substances for several coastal countries.

ADRION region covers eight countries, four are EU member states (Croatia, Greece, Italy and Slovenia), three are EU candidate countries (Albania, Montenegro, Serbia) and one is a potential EU candidate country (Bosnia and Herzegovina). The geographical area of each country covers its national territory except for Italy, where ADRION program area covers just 12 regions and two provinces in 20 regions [30].

Six of these eight countries of ADRION region (Italy, Slovenia, Croatia, Montenegro, Albania and Greece) contributed to this comparative study on environmental impact assessment (EIA), monitoring and decommissioning procedures of offshore platforms, with the scope to harmonize protocols adopted in the ADRION region.

The following institutions, belonging to both research and monitoring sectors, collected and shared their information: Institute for Environmental Protection and Research (ISPRA) and National Institute of Oceanography and Applied Geophysics (OGS) for Italy, National Institute of Biology (NIB) and Slovenian Environment Agency (ARSO) for Slovenia, Institute of Oceanography and Fisheries (IOF), Ruder Boskovic Institute (RBI) and Croatian Hydrocarbon Agency (CHA) for Croatia, University of Montenegro—Institute of Marine Biology (UOM-IMBK) for Montenegro, Agriculture University of Tirana (AUT) for Albania, Hellenic Center for Marine Research (HCMR) and Region of Western Greece (RWG) for Greece.

The level of coherence and consistency in the Adriatic-Ionian marine subregions in terms of implementation of EU environmental policies and Land Based Sources Protocols of Barcelona Convention (MEDPOL Program) [31] is considered low, particularly in the case of contamination of hazardous substances.

Information was collected through four questionnaires (see Supplemental Materials Tables S1–S4) which were distributed in April 2019 by HarmoNIA partners to public authorities of six countries to collect information on the procedures of EIA, monitoring and decommissioning of offshore platforms. The questionnaires were set up to gather information on legislations, protocols and guidelines for above-mentioned topics. In particular, platform installation operation and PFW discharge were considered as major potential impacts of offshore structures on marine system. For this, the questionnaires' questions were addressed on such two types of impacts. The questionnaires were analyzed by comparing the countries' responses and highlighting both commonalities and differences of procedures, proposing, where possible, a transnational harmonization in the ADRION region.

3. Results

Offshore oil and gas exploration and exploitation activities are allowed in Albania, Croatia, Greece, Italy and Montenegro, but they are prohibited in Slovenia according to the Mining Act. Only three countries registered installed offshore platforms: 125 platforms in Italy, 20 in Croatia and 3 active licenses in Greece (no platforms yet in the Ionian sector). Slovenia and Montenegro have no offshore platforms.

Regarding the restrictions for prospecting, research and cultivation of liquid and gaseous hydrocarbons with respect to the distance from the coastline and marine protected areas (AMP), Greece and Albania have no limitations while Croatia, Montenegro and Italy have established some restrictions. In particular, Italy has recently established restrictions within 12-miles from the coastline and marine and coastal areas subjected to environmental protection measures of any kind. Croatian restrictions are: 10 km from the continental coastline (15 km in highly protected marine areas), 6 km from the outer line of the islands and specific limitations are established for waterways, archaeological sites, tourist zones and mine suspected areas. The government of Montenegro has set a minimum separation distance from the shore of 3 km.

The main issues of EIA, monitoring and decommissioning procedures in ADRION region are separately described below and finally a proposal of harmonized procedures is discussed.

3.1. EIA Procedure

Information was collected through two questionnaires dedicated to EIA procedure in case of platform installation and PFW discharge, respectively.

Table 1 resumes the comparison of the main EIA topics in the ADRION region.

Table 1. Environmental impact assessment: main topics considered at ADRION scale.

Topic	Albania	Croatia	Greece	Italy	Montenegro	Slovenia
EIA legislation	√	√	√	√	√	√
EIA for projects with environmental impacts across boundaries	√	√	√	√	√	√
Offshore Protocol of the Barcelona Convention	√	√				
Installation EIA	√	√	√	√	√	√
PW discharge EIA		√	√		√	
EIA report guidelines	√		√		√	√
PW discharge legislation	√	√		√	√	
PW discharge monitoring guidelines				√		

All countries comply to a national EIA legislation which transposes specific European directives, the more recent Directive 2014/52/EU [32] or previous ones. In particular, all countries establish an EIA authorization procedure in the case of projects that may have significant adverse environmental impacts across boundaries. Regarding international conventions or regional agreements regulating environmental impact of the offshore oil and gas platforms, although the Barcelona Convention and UNCLOS have been ratified by all countries, only Croatia and Albania have ratified the Offshore Protocol of the Barcelona Convention [31].

In Italy and Greece, legislation requires an EIA procedure specific for installation of offshore platforms. In other countries, such projects must be submitted to EIA procedure, but there is no specific EIA for offshore platforms. The EIA procedures for offshore platform installation are similar at ADRION level according to the following general steps: (i) presentation of the EIA report by the offshore developer (oil company); (ii) initiation of the EIA procedure, public consultation and advice acquisition; (iii) examination by the Competent Authority of the information presented in the EIA report; (iv) reasoned decision by the Competent Authority on the significant impacts of the project for the environment, including mitigation and monitoring measures. Minimum information to be included in the EIA report is: (i) description of the project (information on the site, design, size,

etc.); (ii) description of the likely significant effects of the project on the environment; (iii) description of the mitigation measures and possible alternatives [33].

The discharge of PFW is to be included into EIA procedure in Croatia, Montenegro and Greece, although not specifically mentioned in the national legislation. In fact, EIA is mandatory for the exploitation of the hydrocarbons and PFW treatment is included in the EIA procedure as part of the exploitation process. Concerning the PFW, EIA is not mandatory in Albania and Italy, although Albania has specific legislation concerning PFW discharge. In Italy, the project developer can choose to submit PFW discharge to EIA procedure or be compliant for PFW discharge to the provisions required by a specific national Decree of 1994 [34]. In these two countries, the request for the authorization of PFW discharge includes information about: (i) installation (marine district, type of production, geographic position, etc.), (ii) discharge (geometry of the pipe discharge, expected volumes of PFW discharge, physical-chemical and ecotoxicological characterization of PFW and potential chemicals used), (iii) marine environmental features (local meteorological and oceanographic conditions; description of the biocoenosis; presence of marine protected areas (MPAs)), (iv) mariculture activities or other sensitive areas, (v) specific monitoring plan aimed to verify the absence of hazard for marine ecosystems.

In the whole ADRION area, the EIA process requests a monitoring project to characterize environmental components, as a baseline study, to further assess potential negative impacts.

3.2. Monitoring Procedure

Information on the monitoring procedures was gathered at ADRION scale from Croatia, Greece, Italy and Montenegro. Table 2 reports some details on monitoring procedures.

Table 2. Monitoring: main topics considered at ADRION scale.

Topic	Croatia	Greece	Italy	Montenegro
Mandatory & flexible monitoring plan	√	√	√	√
Common strategy	√	√	√	√
Corrective (mitigation) measures			√	√
Monitoring plan guidelines			√	
Topics of the monitoring plan	√	√	√	√

In all countries, an environmental monitoring plan is mandatory for monitoring impacts due to offshore platform installation and PFW discharge. The plan contains the strategy to be applied to monitor potential environmental impacts due to the project (installation or PFW discharge). It is a flexible tool, which can be customized and updated according to circumstances. The monitoring plan must be related to the nature, location, size of the project and its significant environmental effects. Previous environmental monitoring datasets, when available, should be taken into consideration to modulate monitoring activities and costs.

The elaboration and implementation of the environmental monitoring plan is an obligation for the exploitation company, but monitoring activities are usually carried out by appointed institutions or technical bodies, with specific expertise in marine environmental monitoring and protection. The company is the only responsible for covering the costs for the environmental monitoring plan, within the licensed area for exploration and exploitation of hydrocarbons. The environmental monitoring plan aims to assess possible negative impacts and hazards on the environment due to the project.

Three steps are usually followed for assessing potential impacts: (i) analysis of the Environmental Impact Report or the environmental state overview before the project; (ii) determination of monitoring activities to assess environmental impacts due to the project; (iii) application of corrective/mitigation measures and verification of their effectiveness.

The monitoring strategy includes the measurement of suitable biologic, chemical and physical parameters in different matrices (e.g., water, sediment and biota). Corrective (mitigation) measures offer

prevention, reduction and elimination of significant negative impacts on the environment. Corrective actions are mentioned in the monitoring strategy in Italy and Montenegro.

Another step of monitoring procedure concerns public information about the monitoring activity, its results and any corrective measures. Monitoring results are publicly shared by websites of the competent authorities or environmental protection agencies or local authorities involved.

Only in Italy there are guidelines for the preparation of the monitoring plan of the projects subject to EIA procedure, in which offshore platforms can also be included [35,36]. There are also specific Italian guidelines for monitoring impacts of PFW discharge into the sea [37].

Nevertheless, the main topics of the monitoring plan (e.g., sampling strategy, parameters to monitor, etc.) are common among Italy, Croatia and Greece. In Montenegro, the legislation concerning these issues does not specify monitoring details but indicates that a plan should contain parameters based on which adverse environmental impacts may occur (location, method, frequency of measurements).

In Italy, Croatia and Montenegro the environmental monitoring plan is characterized by three phases of monitoring: pre-installation, installation and post-installation of the offshore platform. In case of PFW discharge, the monitoring covers the period before discharging PFW into the sea and during the whole period covered by the discharge authorization. Greece considers monitoring of pre- and post-installation: an initial sampling survey is required to define baseline values (background) for environmental parameters; a final monitoring is carried out, with a minimum survey frequency once per year. It is recommended that data should also be collected on a more frequent basis within the year in order to enable the assessment of trends within shorter time scales.

Generally, the survey area corresponds to the portion of the sea and seafloor in which significant impacts are expected on the environmental components affected by the platform installation. This is a broader licensed area for exploration and exploitation of hydrocarbons, and it includes the area close to the platform too. In the case of PFW discharge, Italian guidelines establish the survey area of 500 m from the discharge point.

Usually, the sampling strategy depends on expected impacts, size of the survey area and its vulnerability, monitoring parameters, operation of other environmental monitoring networks, presence of anthropogenic and natural "external" environmental pressures (not attributable to the project) that can interfere with the monitoring results.

In particular, sampling details are established in Italian guidelines in case of installation and PFW discharge [2]. Air, seawater, sediment and biota are reported as matrices potentially affected during the construction and operation of the offshore platforms. In particular, in Italy water, sediment and biota are considered representative matrices of the marine environment. In Greece, information is required on physical/chemical properties and current dynamics of marine waters; local meteorology; the seabed especially for its role on the health of marine ecosystems; parameters related to the avoidance of accidents with environmental impacts in the area closer to the platform.

A heterogeneous approach is applied within the ADRION area to define sampling frequency and parameters to monitor in water, sediment and biota. Usually, 1–2-monitoring surveys per year are carried out for all matrices, but only Italian guidelines include sampling frequency differentiated according to project phases (installation or PFW discharge).

Specific details about parameters to be measured are usually not included in the national laws. In Greece, legislation refers to physicochemical and chemical-biological properties of marine water and analysis of metals and hydrocarbons in sediments in case of PFW discharge. Also, Greek legislation indicates some biological analyses (assessment of the ecological status of important benthic communities, including *Posidonia oceanica*, coral and chemosynthetic meadows communities and bioaccumulation of hydrocarbons and heavy metals in bivalves and fish), without referring to the type of pressures (installation or PFW discharge). Indicators of ecosystem services that the sea offers to local societies, including fishing and tourism, are also mentioned. The Croatian legislation requires biologic and toxicological analysis in mussels, while the Italian one indicates specific parameters for water, sediments and biota for monitoring the impacts of projects subject to EIA procedure (e.g., platform

installation) or PFW discharge. Moreover, Italy and Croatia establish an oil concentration limit of 40 ppm in PFW discharge. In addition, a Croatian more restrictive threshold of 15 ppm is also established for hydrocarbons in water. Moreover, in Italy a concentration limit of 3500 ppm is also established in PFW discharge for the production chemical "diethylene glycol".

The quality status of the water column, sediments and biota is assessed on the basis of quality standards (i.e., threshold values based on average and/or maximum allowable quantities) required by European directives [38,39] and/or national laws [40–42]. For Montenegro and Croatia, threshold values depend on the decision of the authority which is competent for environmental monitoring approval.

3.3. Decommissioning Procedure

Table 3 reports details of HarmoNIA participants' response comparative analysis.

Table 3. Decommissioning: main topics considered at ADRION scale.

Topic	Croatia	Greece	Italy	Montenegro
Expected decommissioning	√		√	
National legislation	√	√	√	√
Forbidden abandonment	√	√	√	√
Decommissioning guidelines			√	
EIA for removal	√	√	√	√
Monitoring during removal	√	√	√	√
Restoration measures		√	√	√
Partial removal, alternative use (reuse)	√	√	√	
EIA for reuse		√	√	

In Italy and Croatia, the decommissioning of several offshore structures is expected in the near future. In particular, the decommissioning of at least twenty Italian offshore structures is foreseen during the next five years. Only in Italy is there an official list of platforms to be subjected to decommissioning, published by the Ministry of Economic Development on its website and updated every year.

Italy, Croatia, Greece and Montenegro have a national decommissioning legislation, conversely in Slovenia offshore hydrocarbon exploitation is forbidden by Law.

Italy is the sole country with approved and adopted national guidelines for decommissioning of the offshore platforms and related infrastructures to ensure the quality and completeness of the assessment of the related environmental impacts [43,44]. The Guidelines allow to define procedures for decommissioning or reusing the offshore platforms, by stimulating use of available technologies for mining, sustainable from both an environmental and social point of view as well as assuring technical and economical feasibility.

The abandonment of offshore platforms and related infrastructures is forbidden in Italy, Greece, Croatia and Montenegro. In these countries, the companies of mining concessions, who intend to remove a platform which has reached its end-of-life, must present a decommissioning project to obtain the authorization from the competent authority.

The decommissioning project must include detailed environmental and technical information (e.g., the structures to be decommissioned, the characteristics of the sea area affected, the method of removal, the planning and description of the removal activities and any possible remediation project).

All countries require an environmental monitoring during the removal activities. For Italy, Greece and Montenegro the environmental restoration of the areas affected by the platform removal (at the end of the removal activities) is mandatory. In Italy, Greece, Croatia and Montenegro, the competent authority verifies by inspection the platform removal, in compliance with the authorized project and draws up the certification of mining activity cessation. In Greece, a committee, composed by three members, sets up the monitoring plan in order to restore the environment to its original condition.

In Italy and Greece, the companies interested in reusing offshore platforms must submit to the competent authority a preliminary project of reuse. In Greece, the projects for the reuse of offshore platforms are submitted for an EIA procedure. In Italy, depending on the typology of the project, an EIA may or may not be required. In Croatia, a national regulatory framework does not provide specific provisions for reuse projects, but they should be subject to EIA. In Italy, the applicant must request a maritime permit for the occupation and use of the area authorized for platform reusing. In Italy and Greece, the competent authority could adopt a denial decision, determining, as a consequence, the rejection of the request, in case there is one or more dissenting regulations which cannot be overcome.

4. Discussion

On the basis of the HarmoNIA analysis, it appeared that a quasi-similar approach is followed by the ADRION countries regarding EIA and monitoring procedures for offshore platforms installation and production. Although this was expected from the EU member states, in compliance with the EU directives, several discrepancies emerged between EU and non-EU countries as well as among EU countries. Regarding platform removal, only in Italy and Croatia the decommissioning of several offshore structures is expected in the near future. Due to limited experience, the harmonization of decommissioning procedures is still an open challenge in ADRION region, but it is important that all countries develop guidelines to identify the best technologies available, so to assure as much as possible environmental compatibility to the whole process, as well as its technical and economic sustainability. In addition, any alternative innovative uses of the offshore platforms should also be promoted, in a circular economy perspective and limiting as much as possible any environmental impacts [23].

The sharing and adoption of the following elements would increase the harmonization of EIA procedure at ADRION level: (i) a common EIA report template including indication of the minimum information required, as specified in the Directive 2014/52/EU [32] and (ii) a common EIA strategy for PFW discharge, including limits of particular pollutant concentrations.

The following main topics may be considered to support a harmonized approach for monitoring environmental impacts due to platform installation and PFW discharge: definition of the survey area, sampling phases, sampling design, matrices to investigate, parameters to investigate and sampling frequency.

For each topic, we report the considerations shared at ADRION scale, within HarmoNIA project.

The survey area may be the broader licensed area for exploration and exploitation of hydrocarbons, and it may also include the area close to the platform. In case of PFW discharge, the survey area should be about 500 m from the discharge point.

The plan may take into account the following three phases of monitoring: (i) preproject or ante operam: an initial sampling survey to define background/baseline values for environmental parameters before the project; (ii) during project: a sampling during implementation of the project, if possible, to define possible alterations within shorter time scales; (iii) postproject or post operam: a final monitoring to enable the assessment of trends of possible alterations within shorter and longer time scales. In case of PFW discharge, the monitoring covers the whole period of discharge authorization.

In order to investigate the impact of the platform structure, a radial sampling pattern can be selected for all matrices, allocating monitoring stations around the platform at a fixed distance from it, rather than using a randomized placement. Further monitoring stations can be included, if vulnerable ecosystems are present in the proximity of the platform. This sampling design is considered more appropriate for tracing any environmental changes when the point source of disturbance is known (e.g., installation). In regard to PFW discharge impact, the water samples can be collected on a transect taking into consideration local hydrodynamics characteristics, if possible, that may affect PFW dispersion from the point of discharge, while sediments can be collected along a transect oriented following the dominant current. Monitoring stations for biota collection may be closed to platform pylons. Furthermore, in order to obtain an exhaustive rigorous environmental framework, all matrices should

also be sampled in a control area, presenting the same geomorphologic characteristics of the investigated area, but not directly influenced by the offshore activities.

All matrices potentially affected by the project must be monitored. In particular, water, sediments and biota are investigated in marine environment; besides, air may be monitored too.

The harmonized environmental monitoring plan proposes to monitor a set of parameters in order to control potential impacts (due to the project) on the marine ecosystem (Table 4). This table reports a list of recommended parameters that should be analyzed for monitoring impacts of offshore platform installation and PFW discharge into the sea. In particular, only core parameters which are essential for monitoring impacts of installation were chosen among those reported in Italian guidelines and in Norwegian guidelines for monitoring impacts of projects subjected to EIA procedure.

Table 4. List of recommended parameters that should be analyzed for monitoring impacts of offshore platform installation and produced formation water (PFW) discharge into the sea.

Monitoring of the Impact of PFW Discharge	**Monitoring of the Impact of the Offshore Platform Installation**
Water column	Water column
salinity, temperature, density, pH, transmittance, turbidity, fluorescence (chlorophyll), dissolved oxygen, current [1], nutrients [2], suspended matter, total hydrocarbons, aliphatic hydrocarbons [3], BTEX [4], phenols, ecotoxicological assays, passive sampling, PFW dispersion model	current, temperature, salinity, density, pH, turbidity, transmittance, dissolved oxygen, fluorescence (chlorophyll), suspended matter, BTEX, total hydrocarbons, aliphatic hydrocarbons, phenols, passive sampling
Sediment	Sediment
macroscopic (visual and descriptive) analysis, grain size, total organic carbon (TOC), total hydrocarbons, aliphatic hydrocarbons [3], BTEX [4], polycyclic aromatic hydrocarbons (PAHs) [5], metals [6], phenol, ecotoxicological assays	grain size, water content, specific gravity, metals (Hg, Cd, Pb, As, total Cr, Cu, Ni, Zn, Mn, Al and Fe), total hydrocarbons, PAHs, butyltin compounds (tributyltin, dibutyltin, monobutyltin) [7], total organic matter, total nitrogen and phosphorus, TOC, microbiological parameters (total and fecal coliforms, fecal streptococci), ecotoxicological assays, others (e.g., Se, Ba, V), BTEX [4], phenol
Biota	Biota
(by catching *M. galloprovincialis* individuals on the platform legs or mussel cages) lipid content, total hydrocarbons, aliphatic hydrocarbons, BTEX [4], polycyclic aromatic hydrocarbons (PAHs) [5], metals [6]	(by catching platform leg mussels/polychaetes) metals (Hg, Cd, Pb, As, total Cr, Cu, Ni, Zn and Fe) others (e.g., Ba, Se, V), PAHs, butyltin compounds (tributyltin, dibutyltin, monobutyltin) [7], fat content, biomarkers, fish assemblage analysis, macrozoobenthic community analysis, visual census of cetaceans

Table 4. *Cont.*

Monitoring of the Impact of PFW Discharge	Monitoring of the Impact of the Offshore Platform Installation
PFW	Sea bottom
pH, total suspended matter, temperature, total nitrogen, nutrients [2,*], sulfates, sulfides, chlorides, salinity, metals [6,*], mineral oils, total organic carbon (TOC), dissolved organic carbon (DOC), particulate organic carbon (POC), biochemical oxygen demand (BOD5), organic aromatic solvents, aliphatic hydrocarbons > C12, hydrocarbons < C12, diethylene glycol, other declared additives, PAHs, phenols, ecotoxicological assays, radionuclides (^{226}Ra, ^{228}Ra, ^{210}Pb in certain cases, also ^{228}Th)	bathymetry and morphology

[1] current measurements at the PFW discharge depth to identifying the direction of the sampling transept. [2] ammonia, nitrites and nitrates as nitrogen, phosphate as phosphorus in dissolved phase (* for PFW: ammonia, nitrites and nitrates as nitrogen). [3] C_6–C_{12} and C_{12}–C_{20}. [4] benzene, toluene, ethylbenzene, o,m,p-xylene. [5] naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene, indenopyrene. [6] lead, vanadium, chromium, barium, copper, iron, mercury, arsenic, cadmium, zinc, nickel (* for PFW all these metals without vanadium and barium to be determined in total and particulate phase). [7] the butyltin compounds should be recommended, particularly in the old platforms. Note: stable isotope ratio of carbon, nitrogen and sulfur in dissolved, particulate and sediments may be analyzed in order to trace the eventual contamination source in case of impact of platform installation and PFW discharge.

5. Conclusions

A harmonized, shared and integrated approach for monitoring and assessment of contaminants at the regional and subregional level is required by both Marine Strategy Framework Directive (MSFD) at EU level and the Ecosystem Approach (EcAp) program adopted by the Barcelona Convention at Mediterranean level. Moreover, a harmonization of procedures of contamination assessment and monitoring may improve the environmental management and protection.

Harmonized plans pave the way towards the adoption of common procedures to assess and monitor potential impacts of potentially dangerous activities, including offshore platforms, on Adriatic-Ionian waters. In addition, harmonized procedures provide a useful tool for collecting and integrating consistent and compatible marine datasets in ADRION region.

Some challenges for managing offshore platform impacts emerged at ADRION level: (i) need of the same legislative level (the Offshore Protocol of Barcelona Convention is not ratified by all countries); (ii) set up of a task force of ADRION experts for discussing critical issues related to impacts of offshore platforms; (iii) harmonization, at the regional level, of EIA procedures, monitoring and decommissioning; (iv) need of an agreed and common list of recommended parameters to monitor in water, sediments and biota for the assessment of impacts due to platform installation and PFW discharge.

Sharing best practices on assessment and monitoring of offshore platform impacts for Adriatic-Ionian region, can strongly improve the adoption of a joint monitoring program in future transnational EIA for offshore infrastructures. Furthermore, detailed and agreed EIA procedures at ADRION level, assure equal and foreseeable economic conditions for operators willing to invest in such highly valuable region.

Supplementary Materials: The following are available online at http://www.mdpi.com/2073-4441/12/9/2460/s1, Table S1: Questionnaire on platform installation EIA procedures; Table S2: Questionnaire on Produced Formation Water discharge EIA procedure; Table S3: Questionnaire on monitoring procedure of impacts due to platform installation and Produced Formation; Table S4: Questionnaire on offshore plaftorm decommissioning procedure.

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