

## **WG 3: Environmental challenges**

### *Second annual report*

The second year of WG3 activities was dedicated on monitoring activities, such as modelling and environmental baseline assessment, in order to evaluate the level of risks and develop a generic strategy for environmental baseline studies and the environmental monitoring of gas production from hydrates. In addition, we continued our research regarding legal framework.

The following products are used to contribute to this report:

- the ECO2 Final Publishable Summary Report<sup>1</sup>;
- the MIDAS final report (WP5)<sup>2</sup>;
- Black Sea state-of-the-art, including geophysical surveys and legal regulation;
- Gas hydrate production test in Nankai trough of Japan performed by JOGMEC in 2012/2013.

First, it is necessary to verify if the selected site responds to pre-criteria, such as morphology with low angle inclination, geotechnical parameters adequate to host the exploitation activities, absence of active gas sources. Then, we should characterize the site from different point of view in order to evaluate possible hazards that could occur during and after the exploitation phases.

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<sup>1</sup> <http://cordis.europa.eu/docs/results/265/265847/final1-eco2-265847-final-publishable-summary-report.pdf>

<sup>2</sup> <http://www.eu-midas.net/>

### *Generic strategy for environmental baseline studies*

Baseline studies are essential to assess the environmental conditions and, for this reason, they should include the following investigations:

1. Geological characterization, including detailed bathymetry, geochemical, mineralogical and petro-physical characteristics of the sediment and geological structures;
2. Biological community of the seafloor and near seafloor sediments (biocenosis);
3. Chemical characteristics of the water column near the seafloor, the seafloor and near seafloor sediments, such as pore water composition, biogeochemical/physical composition, and dissolved benthic fluxes;
4. Physical-chemical characteristics of the water column especially in relation to oxygenation and acidification, i.e. dissolved gasses such as O<sub>2</sub>, CO<sub>2</sub>, and CH<sub>4</sub> as well as other parameter of the carbonate system to enable full determination: pH, DIC, alkalinity; and nutrients, H<sub>2</sub>, SO<sub>4</sub><sup>2-</sup>, H<sub>2</sub>S, Ca<sup>2+</sup>, and total Hardness);
5. Cultural heritage, in order to evaluate the possible acceptance of the society, and mapping of human infrastructures.

Note that some information required to plan the hydrate production could be provided by literature, while other information could only be obtained through dedicated site surveys or monitoring installations.

The baseline studies could be carried out by autonomous underwater vehicles (AUVs) and/or monitoring vessels, equipped with suitable instruments (echo sounders, hydrophones, chemical sensors, still camera, piston corers, landers, benthic chambers etc.) and/or water column monitoring stations. This approach would permit to have full areal coverage.

The geological characterization is necessary to evaluate the possible seafloor deformation hazard. The analysis should be:

- 2D and 3D seismic, OBSs or OBC (maybe already available from site survey);
- high-resolution bathymetry/backscatter mapping of the seabed;
- hydro-acoustic imaging of shallow gas accumulations in the seabed;
- geological/petro-physical/geotechnical characterization of the shallow sediments, including paleo-geological history.

To evaluate the gas release impact on the environment, following studies are recommended:

- gas bubbles imaging ascending into the water column;

- sampling and analysis, including isotopes, of any ascending gases.
- video/photo imaging of biota at the seabed;
- geochemical characterization of the shallow sediments;
- chemical/physical/biological characterization of the seawater;
- biological integrity;
- oceanography measurements to model the transport of sediments;
- chemical detection of dissolved gas and related parameters in ambient bottom waters;
- chemical and isotopic composition of pore water and dissolved gases (fractionating in order to understand the gas origin);
- dissolved benthic flux measurements (chemical and Isotopic composition of dissolved gases and chemicals released or adsorbed by the bottom sea) by benthic chamber deployments;
- habitat mapping.

To evaluate the impact of the exploitation on population and human infrastructures, it is necessary to realize the following studies:

- human infrastructures mapping;
- stakeholder engagement plan (SEP).

To optimize the monitoring step, a site with similar characteristics and same geological context of the selected one should be identified and studied in order to have a reference undisturbed site respect to the site where the activities should be realized.

The results of baseline study will form the input for modeling (geotechnical, geochemical, flow etc.) to predict the evolution of reservoirs during and after the exploitation. In addition, the modeling can be used as tool to plan the monitoring regime and to define the area that may be influenced both temporarily and spatially by the exploitation. The modeling can help to understand if an additional dataset is necessary to complete the baseline study. Commercial software is available for partially modelling site evolution, so we suggest evaluating the possibility to develop new software to enable complete modelling of site evolution.

### ***Generic strategy for environmental monitoring of gas production from hydrates***

After the comprehensive characterisation of the site (baseline study) is complete and the production activity starts, monitoring is necessary in order to identify any anomalies with respect the pre-production state. The first step is to generate a detailed project description based on the baseline study and modelling, in order to identify the main risks for the environment, and assess the potential impacts. From the environmental impact assessment, a recommendation of mitigation measures and a plan for environmental management and monitoring should be established. The next step is to plan the management and monitoring strategy based on the risk and impact assessment.

Surveys carried out during the baseline study should be repeated. It could include autonomous underwater vehicles (AUVs), monitoring vessels, water column moorings and benthic chamber deployments, as used for the baseline study. They can be equipped with suitable instruments (echo sounders, hydrophones, chemical sensors, still camera, etc.) to conduct multiple surveys with full areal coverage. However, each surveys should be conducted at a specific height above the seabed, along with permanent monitoring of the seabed by fixed installations such as observation wells and deployed sensors, to achieve optimal results. Additional targeted studies will have to be conducted if active formation water seeps, gas seeps, and pockmarks with deep roots reaching into the storage formation are observed at the seabed.

These sites must be revisited on a regular basis to determine emission rates of gases and fluids and determine if any seepage is strengthened and/or pockmarks are re-activated by the storage operation. If new seeps develop during the operational phase, they must be investigated and sampled in detail to determine the origin and chemical composition of the seeping fluids and gases and their emission rates. These studies could be conducted with remotely operated vehicles (ROVs) deployed from suitable monitoring vessels, and by monitoring data from permanent installations on the seabed (observation wells and deployed sensor on and above the seafloor). Samples should be taken for chemical analysis and instruments deployed at the seabed to measure fluxes and emission rates.

### *Answer of the questions of the first year report*

The baseline study can help us to answer the three questions defined during the first year of the project and here reported:

1. How long do you need to monitor in order to capture natural episodic or seasonal processes during the crucial baseline monitoring?  
*Answer: the modelling and the baseline study can help to quantify the space and time necessary.*

How to differentiate between natural hydrate destabilisation (e.g. climate change, continued re-equilibration after ice age) and induced through production activities? *Answer: continuous time series data recorded and modelling are needed to capture the variability of the systems. Stationary lander systems have been applied successfully by academia to record time series data at cold seep sites (e.g. gas flux quantification based on hydro-acoustic bubble detection, fluid flow meters based on osmosis sampling). These systems are now commercially available and should thus be employed during the baseline study and monitoring phase at active seeps located above the production area.*

2. How to determine 'proof' for regulatory and/or liability purposes?  
*Answer: we can start by using the existing legislation, for example that applied in the Black sea area (described below).*

## ***Proof for legal framework:***

### ***Bulgarian Environmental and Maritime Legislative Framework Relevant to the Gas Hydrates Exploration and Production***

#### ***1.Introduction***

This overview reviews and characterizes the key legal framework relevant to the marine gas hydrate exploration and production in the EEZ of Bulgaria.

#### ***2.International Legislation***

##### ***2.1. Conventions***

The following conventions are of key importance for all offshore research, exploration and production activities in the Black Sea:

- MARPOL 73/78 (Annexes I, IV and V) – this international convention and its annexes are valid and subject of obligatory consideration for any human activities in the World Ocean and therefore are well known to all users of the marine environment and do not need to be commented;
- 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter of 29 December 1972:
  - The 1996 Protocol is more restrictive than the Convention 1972 and "prohibits the dumping of any wastes or other matter with the exception of those listed in Annex 1" (Art. 4 (4.1)), among which are the "inert, inorganic geological materials". This means that the disposal of the drill cuttings, as well other disposal related to offshore exploration/drilling activities on the seabed within the boundaries of the shelf (territorial waters) and exclusive economic territories of the relevant country is under the control of 1996 Protocol.
  - The dumping of the wastes requires a permit (Art. 4 (4.2)), which is necessary to be issued by the Ministry of Environment and Water (MOEW); Regional Inspection of Environment and Water (RIEW – Varna or RIEW-Burgas). For the issuing of the permit an application form is necessary to be submitted to the competent authority (MoEW; RIEW – Varna / RIEW-Burgas). The application shall also be in compliance with the provisions of Annex 2 of the above quoted Protocol.
- 1994 Convention of the Protection of the Black Sea against Pollution (Bucharest Convention). The Bucharest Convention is the basic framework of agreement and it has three specific Protocols, as follows: 1) Protocol for the control of land-based sources of pollution; 2) Protocol for prevention, reduction and control of the pollution by dumping of waste and 3) Protocol for joint action in case of accidents (such as oil spills):

- Art. 10 of the Bucharest Convention states that: “The Contracting Parties shall take all appropriate measures and cooperate in preventing, reducing and controlling pollution caused by dumping in accordance with the Protocol on the Protection of the Black Sea Marine Environment Against Pollution by Dumping which shall form an integral part of this Convention”.
- The Protocol on the Protection of the Black Sea Marine Environment Against Pollution by Dumping (PPBSMEAPD) states that:
  - ✓ Dumping of wastes or other matter containing substances listed in Annex 1 to this Protocol in the Black Sea is prohibited (Art. 2);
  - ✓ Dumping of wastes or other matter containing noxious substances listed in Annex II to this Protocol in the Black Sea requires, in each case, a prior special permit from the competent national authorities (Art 3);
  - ✓ Dumping of all other wastes or matter in the Black Sea requires a prior general permit from the competent national authorities. (Art. 4) and
  - ✓ The permits, which refer to the requirements of articles 3 and 4, mentioned above, shall be issued after a careful consideration of all factors, set forth in Annex III to this Protocol, by the competent national authorities of the relevant coastal State. The Commission shall receive records of such permits (Art 5).

***Annex I*** to the Protocol on the Protection of the Black Sea Marine Environment against Pollution by Dumping lists the following chemicals (hazardous substances and matter):

1. Organohalogen compounds e.g. DDT, DDE, DDD, PCB's;
2. Mercury and mercury compounds;
3. Cadmium and cadmium compounds;
4. Organotin compounds;
5. Persistent synthetic materials which may float, sink or remain in suspension;
6. Used lubricating oils;
7. Lead and lead compounds;
8. Radioactive substances and wastes, including used radioactive fuel;
9. Crude oil and hydrocarbons of any origin.

## ***Annex II*** (Noxious Substances and Matter)

The control and strict limitation of the discharges of substances and matter referred to in this Annex shall be implemented in accordance with Annex III to this Protocol.

1. Biocides and their derivatives not covered in Annex I;
2. Cyanides, fluorides, and elemental phosphorus;
3. Pathogenic micro-organisms;
4. Non-biodegradable detergents and their surface-active substances;
5. Alkaline or acid compounds;
6. Thermal discharges;
7. Substances which, although of a non-toxic nature, may become harmful to the marine biota owing to the quantities in which they are discharged e.g. inorganic phosphorus, nitrogen, organic matter and other nutrient compounds. Also substances which have an adverse effect on the oxygen content of the marine environment;
8. The following elements and their compounds: a series of heavy metals including Barium;
9. Crude oil and hydrocarbons of any origin.

## ***Annex III***

In issuing permits for dumping at sea, the following factors shall be considered:

### ***CHARACTERISTICS AND COMPOSITION OF THE MATTER***

- Amount of matter to be dumped (e.g. per year);
- Average composition of the matter to be dumped;
  - Properties: physical (e.g. solubility, density), chemical and biochemical (e.g. oxygen demand, nutrients), biological (e.g. presence of bacteria, etc.) (The data should include sufficient information on the annual mean levels and seasonal variations of the mentioned properties);
- Long-term toxicity;
- Persistence: physical, chemical, biological;
- Accumulation and transformation in the marine environment;
- Susceptibility to physical, chemical and biochemical changes and interaction with other dissolved matter;

- Probability of inducing effects which would reduce the marketability of resources (e.g. fish, shellfish).

### *CHARACTERISTICS OF DUMPING SITE AND DISPOSAL METHOD*

- Location (e.g. coordinates of the dumping area, depth and distance from the coast) and its relation to areas of special interest (e.g. amenity areas, spawning, nursery and fishing grounds);
- Methods and technologies of packaging and disposal of matter;
- Dispersal characteristics;
- Hydrological characteristics and seasonal variations in these characteristics (e.g. temperature, pH, salinity, stratification, turbidity, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, nutrients, productivity);
- Bottom characteristics (e.g. topography, geochemical, geological and biological productivity);
- Cases and effects of other dumping.

## **2.2. *Relevant EU Directives***

The following EU Directives are of key importance for the offshore oil and gas exploration and production activities:

### *A. General aspects*

- DIRECTIVE 2013/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC.
- DIRECTIVE 2004/35/CE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage (Environmental Liability Directive or ELD).
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Waste Framework Directive).
- DIRECTIVE 2012/18/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (Seveso III Directive).
- Directive 94/22/EC of the European Parliament and the Council of 30 May 1994 on the conditions for granting and using authorizations for the prospection, exploration and production of hydrocarbons (Hydrocarbons Directive).

- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

## B. *Biodiversity*

- Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment (Environmental Impact Assessment Directive or EIA Directive). *This Directive applies to the assessment of the environmental effects of those public and private projects which are likely to have significant effects on the environment. Member States have to adopt all measures necessary to ensure that, before consent is given. Projects likely to have significant effects on the environment by virtue, inter alia, of their nature, size or location are made subject to a requirement for development consent and an assessment with regard to their effects.*
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive). *The Habitats Directive ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. Some 200 rare and characteristic habitat types are also targeted for conservation. The Directive stipulates the establishment, protection and management of a coherent European ecological network of special areas of conservation in the geographical sea and land (Natura 2000). This network aims to maintain or, where appropriate, restore the favorable conservation status of the targeted natural habitat types (listed in Annex I) and habitats of the species (listed in Annex II).*
- Directive 2009/147/EC on the conservation of wild birds (Birds Directive). *Europe is home to more than 500 wild bird species. At least 32 % of the EU's bird species are currently not in a good conservation status. The Birds Directive aims to protect all of the 500 wild bird species naturally occurring in the European Union. It stipulates the establishment, protection and management of a coherent European ecological network of special protection areas for the conservation of wild birds in the geographical sea and land (Natura 2000).*

The main part of these directives is already adopted by the Bulgarian national legislation In the process of its harmonization with the EU legislation. The remaining part (in particular the DIRECTIVE 2013/30/EU on safety of offshore oil and gas operations and amending) are still in process of harmonization.

### 2.3. *Good International Practice Documents*

Due to the lack of specific legal acts for regulation of offshore oil & gas exploration and production activities the Bulgarian authorities are using for the administrative procedures for granting exploration licenses (exploration permits) and concessions for production of oil in gas in the offshore blocks located in the Bulgarian territorial waters and EEZ some basic rules and requirements formulated in international good practice documents (codes, regulations, manuals, etc.). As a typical example can be mentioned the MODU CODE (Code for the Construction and Equipment of Mobile Offshore Drilling Units), issued by the International Maritime Organization (IMO), London, 2001. For some specific aspects are also used the basic principles and rules of the offshore oil and gas legal framework of UK and Norway.

### **3. *National Legislation***

#### **3.1. *Oil & Gas Exploration***

The following legal acts are in force and applicable for the offshore oil & gas exploration and production activities:

- Mineral Resources Act and the Ordinance for Specific Requirements for Mining Waste Management. These legal acts regulate all onshore kinds of prospecting and exploration activities for mineral resources and fossil fuels, as well production activities, as well regulates the administrative procedures for granting exploration licenses (exploration permits) and concessions for production of mineral resources and fossil fuels; also specifies the management of the mining wastes, generated from the exploration, extraction and primary processing of mineral resources (Art 1 § 3), including also onshore extraction of oil and gas (Art 2 § 3). They don't include and consider the wastes, generated as a result of the same operations, conducted offshore (Art 22a § 3). It should be underlined that in these documents are absent any special provisions regulating offshore prospecting, exploration and production activities for oil and gas (as well for marine gas hydrates respectively).
- Maritime Spaces, Inland Waterways and Ports of the Republic of Bulgaria Act (2002). The Act transposes the recommendations of MARPOL 73/78 and European Directive 2000/59/EO in BG legislation and regulates all maritime activities in the inland waterways, ports, territorial water and EEZ of Bulgaria (including scientific research, exploration and production of mineral resources, oil and gas, etc.) ;
- Mineral Resources Act and the Ordinance for Specific Requirements for Mining Waste Management. These legal act regulates all onshore kinds of prospecting and exploration activities (onshore and offshore) for mineral resources and fossil fuels, as well production activities, as well regulates the administrative procedures for granting exploration licenses (exploration permits) and concessions for production of mineral resources and fossil fuels; also specifies the management of the mining wastes, generated from the exploration, extraction and primary processing of mineral resources (Art 1 § 3), including also onshore extraction of oil and gas (Art 2 § 3). They don't include and consider the wastes, generated as a result of the same operations, conducted offshore (Art 22a § 3);

- Regulation on safety of offshore oil and gas operations (Draft). This draft regulation transposes the provisions of DIRECTIVE 2013/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 June 2013 on safety of offshore oil and gas operations. The draft regulation is currently in process of discussion and coordination in the Legal Commission of the Bulgarian Parliament and it is expected to be approved by the Council of Ministers soon.

### **3.2. *Marine Physical Environment Protection***

With respect to the substances, listed in Annex I of PPBSMEAPD, the following national legal documents should be considered:

- Ordinance H-4 on the Characterization of Surface Water (StateGazette/SG 22/2013, last amended 2014). Potential organic and inorganic pollutants and their maximum permitted values, including PCB's, organophosphorus compounds, oils and heavy metals, except barium are included in the Annexes of the Ordinance. The specific issue here is that this ordinance refers to the littoral but not offshore water quality.
- Ordinance № 3/2014 on the Requirements of the Order and Manner of Inventory of Equipment Containing Polychlorinated Biphenyls, Marking and Cleaning, as well as Treatment and Transportation of Wastes Containing Polychlorinated Biphenyls (SG 21/2014). PCB's contaminated wastes have to be disposed for incineration and their transportation has to be carried out in accordance with the Ordinance for transportation of hazardous wastes.
- Act on Protection against Harmful Impact of Substances and Mixtures (SG 63/2010). This Act states the rights and obligations of individuals and firms that manufacture, market, use, keep and export chemical substances on their own or in mixtures in order to protect human health and the environment. It does not relate to the protection of surface waters by chemical pollution, including disposal of chemical substances in the sea.

The following key general legal documents developed in general for onshore human activities are applicable as well for offshore activities:

- Environmental Protection Act (2002, last amendments 2008). This legal act is fully harmonized with the EU EPA Directive.
- Ordinance for the Conditions and Order for Implementing EIA (2003, last amendments 2011). This legal act is fully harmonized with the EU legislation.

### **3.3. *Marine Biodiversity Protection***

- Environmental Protection Act (EPA) (2002, last amendments 2016). *This act regulates the public relations associated with protection of the environment for the present and future generations and the protection of human health; conservation of biodiversity in accordance with natural bio-geographical characteristics of the country; conservation and use of components of the environment; control and management of the factors that damage the environment; control of the state of the environment and sources of pollution; preventing and reducing pollution; establishment and functioning of the National System for Environmental Monitoring; strategies, programs and plans for environmental protection; collection and access to environmental information;. economic organization of activities on environmental protection; rights and obligations of the state, municipalities, companies and individuals in environmental protection. This legal act is fully harmonized with the EU EPA Directive.*
- Ordinance on conditions and procedures for execution of Environmental Impact Assessment (2003, last amendments 2016). *This ordinance stipulates the procedures for execution of Environmental Impact Assessment of the investment proposals, as per art. 81, paragraph 1 pt. 2 of EPA.*
- Biological Diversity Act (BDA) (2002, last amendments 2016). *This Biodiversity Act regulates the relations between the state, municipalities, companies and individuals in the conservation and sustainable use of biological diversity (i.e. the variety of all living organisms in all forms of their natural organization, their communities and habitats, ecosystems and processes) in Bulgaria. The Biodiversity Act stipulates the establishment, management and protection of the Natura 2000 network in Bulgaria, as part of the European Ecological Network. This legal act is fully harmonized with the EU legislation.*
- Ordinance for the terms and conditions for assessment of the compatibility of plans, programs, projects and investment proposals with the object and purpose of conservation of protected areas (2007, last amendments 2012). *The ordinance regulates the terms and procedures for the execution of Appropriate Assessment (as per art. 31 of BDA) for the compatibility of plans, programs, projects and investment proposals with the conservation objectives and purposes of Natura 2000 sites.*

### **3.4. Marine Cultural Heritage Protection**

- Law on the Cultural Heritage (2009, last amendments 2012). This legal act is fully harmonized with the EU Directives and regulates also all aspects of the underwater cultural heritage.

### **3.5. Competent Bulgarian Authorities**

The competent Bulgarian authorities are:

- A. Maritime Aspects, Scientific Research, Exploration & Production of Oil & Gas

- Council of Ministers (issues permits for research and exploration of mineral and energy resources);
- Executive Agency Maritime Administration at the Ministry of Transport and Communications (regulates and controls all maritime activities);
- Ministry of Education and Sciences;
- Ministry of Exterior Affairs (receipt of applications of foreign entities for conducting scientific/research cruises of research vessel in Bulgarian territorial waters and EEZ and proposes to the Council of Minister the applications to be approved and permits to be issues);
- Ministry of Interior Affairs / Border Police;
- Ministry of Education and Science;
- Ministry of Energy (responsible for the administrative procedures for issuing/granting exploration licenses and production concessions for oil and gas in Bulgarian territorial waters and EEZ);
- Ministry of Economics;
- Ministry of Defense / Bulgarian Navy (obligatory coordination of the plans for offshore research and exploration/production activities with these authorities).

#### B. Marine Environment and Marine Cultural Heritage Protection

- Ministry of Environment and Water (issues environmental permits);
- Executive Environmental Agency (responsible for the national marine environment monitoring) ;
- Black Sea Basin Directorate;
- Regional Inspectorates of Environment and Water in Varna and Burgas;
- Ministry of Culture / Centre for Underwater Archaeology (underwater cultural heritage protection).