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Evaluating China's Environmental Management and Risks Avoidance Policies and Regulations on Offshore Methane Hydrate Extraction

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Abstract: Methane hydrates (hereinafter, MH), for many reasons, are widely recognized as a form of sustainable energy due to their environmentally friendly nature. MH, while burning, produce fresh water, which could in turn offer one possible solution to worldwide shortages of water. MH also maintains the capacity to change the landscape of the global energy supply. According to recent scientific evaluations, the potential global supply of MH is even higher than the total storage of traditional crude oil and conventional natural gas. However, its offshore extraction process could be linked to both catastrophic and non-catastrophic events that may contribute to global warming and climate change, cause harm to human health and life, endanger the flora and fauna, and threaten the very global environment as a whole. Therefore, from a legal viewpoint, an efficient and effective system of civil liability rules seem crucial to control the risks, and to compensate the victims to which damages may occur. This article takes into consideration China's legal framework in assessing the risks connected to MH offshore extraction. Such a choice for examination is justified by China's leading position for implementing the technology necessary for extracting MH. This analysis shows that China's current legal instruments are still far from fully equipped to prevent the risks associated with the offshore extraction of MH, as well as to offer effective remedies for the victims once any damages have occurred. Therefore, more efficient measures and remedies should be considered (or even imposed) to address the specific risks of offshore methane hydrate extraction. Indeed, in the past few decades, China's environmental protection laws and regulations have mainly focused on the environmental risks that may occur during the process of extracting conventional resources; however, they do not address methane hydrates specifically. This presents a legal challenge for environmental protection laws. The potentially catastrophic events that may occur as a result of the offshore MH extraction processes in particular present a legal challenge for environmental protection laws in China and across the globe. Thus, this article focuses on how to prevent these risks before they even occur, followed by a careful attempt to address compensation efforts for any damages caused by said catastrophes.

Keywords: methane hydrate; environmental protection; china; offshore; natural resources management; sustainable development

1. Introduction

1.1. The Benefits of Offshore Methane Hydrate Extraction

Generally speaking, burning methane [1] (pp. 323–324) releases fewer carbon emissions than either crude oil or coal [2] (p. 671). This is because methane hydrates (MH) are acid-free, containing fewer impurities than natural gas. Contrarily, the combustion of coal of average quality releases significant levels of pollution and, therefore, causes substantial risks to human health [3]. Additionally, ash derived from coal combustion contains large quantities of radioactive materials. By comparison, the overall environmental pollution stemming from methane combustion is sensibly less than coal, as clearly indicated by the Table 1 below.

Table 1. Carbon Emissions from Energy Sources.

Fuel Source	Carbon Emissions
Coal	27 kg/GJ
Crude Oil	21 kg/GJ
Methane	15 kg/GJ

Source: [2] (p. 671).

From a scientific viewpoint, methane hydrates can be separated from hydrogen. MH is widely recognized as one of the cleanest fuel sources, because its combustion merely emanates energy and water [4]. Therefore, MH poses as one of the world's major potential sources of a globally hydrogen fuel supply [5].

Due to their large presence of hydrogen, MH contain large portions of water. Therefore, while methane is extracted from the methane hydrate, there is a large amount of water that may also be captured. Moreover, the combustion of methane hydrates also releases fresh water. By comparison, coal and crude oil combustion does not generate nor release fresh water, but rather consumes large amounts of it.

Therefore, current methane hydrate extraction technology could generate "green methane". Due to the icy structures of both methane and water, the extraction of methane volumes from methane hydrate deposits could simultaneously enable carbon sequestration while replacing the methane with carbon dioxide [1]. Alternatively, the methane may be combusted on-site to generate electricity, while the remnants may be re-injected into the hydrate deposits for Carbon capture and storage (CCS) [6].

From a policy viewpoint, methane hydrate extraction may change the landscape of the global energy supply, in which it is expected to mitigate the imminent energy crisis. According to scientific evaluation, the globe's potential storage of MH is even greater than that of the total storage of traditional crude oil and natural gas. As Roy Andrew Partain stresses, "the overall scale of this new energy resource, of offshore methane hydrate, has been estimated at 100-times the currently identified commercial reserves of petroleum and natural gas; bluntly put, the volumes of known petroleum and natural gas are a rounding error within the estimates of offshore methane hydrate" [7] (p. 220). Geographically speaking, methane hydrates are believed to be mostly located offshore, as compared to the varying locations of natural gas and crude oil. (Englezos & Lee research suggests a comparable number of traditional natural gas reservoirs at 370 Tcm, but show methane hydrate as being between 10,000 and 20,500 Tcm [2] (p. 671))

1.2. The Hazards of Offshore Methane Hydrate Extraction

Although MH initially appears to be a cleaner energy source than traditional crude oil and gas, there has not been any large-scale commercial extraction, because of the uncertainties of its related technology, particularly regarding the environmental risks these technologies may pose [8]. Based on

current research, offshore methane hydrate extraction may present the following risks, as indicated in the following Table 2 below.

Table 2. Risk Factors and Impacts for Offshore Methane Hydrate Development [7] (p. 236).

No.	Risk Factor	Impact
1	Greenhouse Gas Emissions	Global Warming
2	Water Quality Change	Impact on Marine Life
3	Lightning	Impact on Marne Life and Birds
4	Interference with Fishery	Impact on Fishery
5	Seafloor Disturbance	Impact on Benthic Community
6	Underwater Noise	Impact on Marine life
7	Sediment Resuspension	Impact on Benthic Community
8	Increase in Turbidity	Impact on Benthic Community
9	Marine Sediment Change	Impact on Benthic Community
10	Seafloor Occupation	Impact on Fishery
11	Seafloor Subsidence	Tsunami
12	Submarine Landsides	Tsunami
13	Cracks in Deposit—Disrupt Methane Entry to Sediment	Impact on Benthic Community
14	Cracks in Deposit—Methane Leakage from Sediment	Global Warming
15	Flaring—Lightening	Impact on Marine Life and Birds
16	Flaring—Greenhouse Gas Discharge	Global Warming

These risks are both conventional and unconventional. As for the latter, distinct characteristics remain that require further investigation and attention. For instance, the preparations of MH production fields involve a variety of different types of drilling and vibration-inducing activities. Extraction may very well include various heating injections and flooding techniques [2]. The depletion of large amounts of methane, or even water, could cause hydrate beds to collapse, in turn leading to structural damage. Methane hydrates are endothermic and are able to be measured so far as the amounts of energy injected, or placed into hydrate deposits, are concerned [2]. Thus, it is possible to substantially limit any unforeseeable catastrophes through imposing restrictions that adequately prevent the overstimulation of hydrate deposits.

In some instances, offshore MH extraction may cause catastrophe, potentially impacting a broad array of coastal communities [9]. During the extraction processes of methane hydrates, large sections of hydrate fields collapse, losing its internal structures and causing its mud layers to fall deep into the ocean. These instances could cause for increased sea levels, earthquakes, and even tsunamis [7]. In turn, these events may accelerate the decomposition of methane hydrates, aggravating the already-cataclysmic effects.

These environmental events may affect the victims. Indeed, methane hydrates only exist in certain parts of the sea, where temperatures are cold and pressure is high. Thus, the ecosystems in which methane hydrates are stored are balanced in a very fragile manner. Thus, there is a looming possibility that methane hydrate's very structure may not be very stable both during and after the exploratory process. Unlike crude oil and gas, which maintain their shape even after extraction, there is a high risk that MH may be transform from a solid to gaseous methane, one of the most polluting kinds of greenhouse gas that's even more damaging than carbon dioxide [10]. Although the current rate of methane in air is 5% of carbon dioxide, it contributes 15% to the total greenhouse effect [11]. If the available technology is incapable of ensuring the stability of MH during extraction, any leakage of methane exacerbate global warming, as well as cause an increased sea level and temperature. In turn, higher temperatures may also detrimentally alter the atmosphere's storage of methane hydrates, provoking a more catastrophic greenhouse effect.

Additionally, the exploratory and extraction processes may damage the maritime and oceanic landscape. Methane may provoke higher speeds of microbiological oxidation which may consume oxygen in a short period of time, consequentially creating a hostile environment for sea life to survive.

In sum, offshore methane hydrate extraction, similarly to shale gas [12], imposes a real threat to the environment under a variety of different perspectives. Therefore, it is worthwhile to examine any legislative safeguards that could protect the marine and coastal environment from the damage caused by offshore methane extraction.

2. Materials and Methods

In the first part, this article examines both the benefits and drawbacks to the MH extraction process, where we briefly highlight the significance of this process from a policy standpoint (1.1.), as well as the scientific challenges it entails (1.2.). Then, in Part 3, the legal aspects of this process are introduced, and the main legal instruments relevant for the MH extraction practices are examined by considering three distinct stages: pre-extraction (Part 3.1.); during the extraction (Part 3.2.); and post damages (Part 3.3.). Then, a third and more critical part provides an examination of China's legal framework, which does not specifically consider MH particularities. The article closely examines the deficiencies and insufficiencies of China's environmental legal framework [13]. More specifically, three problems, connected with three different moments of the whole process will be identified and addressed: the "certainty" issue (4.1.), connected to the assessment of the situation; the "monitoring" issue (4.2.), connected to the management of the extraction process; and the issues linked to the remedial side of the regulation (4.3), i.e., connected with the sanctions provided by the legal system once the damage has occurred (this will be examined building largely upon the law and economics literature). Lastly, in Part 5, we offer suggestions for correcting those defects, and how to accordingly change the law for each stage considered, then we conclude in Part 6.

In this study, the legal dimension is duly taken into account as a crucial element to improve human safety and risk management in environmental protection; indeed, the "environment" is not only a political, or social, or economic issue, but indeed a legal one as well. For this reason, overall, this article aims to present and evaluate comprehensively the legal and policy issues and the flaws currently existing in the legal framework connected to the very specific activity of MH extraction in China over the three moments identified above, to identify its weaknesses and to propose guidance for law-makers. Those are the boundaries of this analysis.

The methodology employed throughout this article is interdisciplinary, as—in this context—the scientific, technological and legal dimensions are inextricably interconnected. In the first part, scientific data is studied and incorporated into the analysis. Then, in the legal part, normative and descriptive as well as critical and innovative methods are used. Said analysis specifically considers the broader environmental (non-legal) and policy implications of this new extraction process. Furthermore, our research is prospective in a sense that seeks to find viable and effective solutions for future regulations. As such, the article is intended to provide legal guidance for China's policymakers, as well for those interested in minimizing the environmental impacts of MH in our time of climate change.

3. Applicable Environmental Protection Regulations to Offshore Methane Hydrate Extraction

Generally speaking, China's environmental protection laws, and the Environmental Protection Law (EPL) [14–17] in particular, is a rather comprehensive toolbox that includes both ex ante and ex post remedies addressing environmental issues. On the one hand (*ex-ante* remedies), article 56 of the EPL created the mechanism of the environmental impact assessment (EIA). The EIA is an administrative examination that aims to monitor and inspect any prospective damage, in which its general function is to safeguard and protect the environment [13,18]. On the other hand, tort law offers an *ex-post* compensation for victims affected by offshore methane extraction.

3.1. Ex-Ante Measure—The Environmental Impact Assessment

The EPL introduced for the first time in China the EIA, a mechanism applied to all construction projects and activities that could potentially alter the environment [19–25]. As indicated by Article 19 of the EPL, "an environmental impact assessment shall be conducted as legally required in the

preparation of a relevant development and utilization plan, or the construction of a project impacting the environment". Thus, any developmental and utilization plans that fail an EIA, as legally required, cannot be started. Under the amended provision of the EPL, the anchoring institution(s) that issues said EIA may call off, or even totally demolish the construction project (*See* Article 79, EPL).

More specifically, the Marine Environment Protection Law (MEPL) [26] re-emphasized the necessity of conducting an EIA for any offshore project. In accordance with Article 47 of the MEPL, "an entity undertaking a marine engineering construction project shall conduct a scientific survey of the marine environment, prepare a marine environmental impact report (form), and submit it to the marine administrative department for examination and approval before the construction of the project is started".

The MEPL, through taking into consideration both a vertical and horizontal dimension, ensures that decisions are made by considering all aspects involved in an offshore project. First, the MEPL requires that the report following an EIA is submitted, by inferior entities, to the Marine authority. It also requires that the peer departments of the Marine Environmental Authority, such as administrative Departments of Maritime Affairs and Fishery, and the armed forces, should be consulted before approving such a report (form) (*See* Article 47, MEPL). In other words, a successful EIA is needed.

Furthermore, in considering all geographic implications, the Regulation on Managing Marine Project Environmental Impact Assessment (RMMPEIA) indeed requires the National (Central) Marine Administration to review and approve all projects pertaining to sea-resource exploration (*See* Article 6 (3) of RMMPEIA). Unlike other marine projects, which are generally addressed by local authorities, all sea-resource exploration projects—including methane hydrate extraction—should obtain prior approval from the central government. Therefore, it would seem unlikely that local interests are totally divorced from the decision-making process championed by the central government.

Thus, an EIA acts as both an important and mandatory instrument for offshore methane hydrate extraction projects, with the intent to minimize any associated environmental risks. In short, the quality and the inclusiveness of an EIA must be approved in both a centralized and localized fashion, especially in the case of MH extraction due to its high technical complexity and far-reaching impacts.

3.2. The Legal Safeguards of the Extraction Process—The "Three Simultaneous System"

In addition to the previously discussed EIA, the EPL established another important mechanism termed the "three simultaneous system", otherwise known as the "three synchronizations" [27–29]. In accordance with Article 41 of the EPL, "installations for the prevention and control of pollution at a construction project must be designed, built, and commissioned together with the principal part of the project. Installations of the pollution prevention and control facility shall comply with the requirements of the approved EIA report and shall not be dismantled, or left idle, without authorization".

The "three synchronizations" require corporations to seriously consider the importance of environmental protection. As is the case for much of the private sector around the globe, installing environmental protection technologies are not very common because of the overall (and uncertain) costs of said technologies and their installations. This is especially the case for the technologies of the methane hydrate extraction process, as said technologies are still in their introductory phases. Corporations are especially hesitant to buy into environmental technologies given the uncertainties regarding unforeseeable catastrophes, and the broad costs that could result from such realities. Therefore, authorities must carefully supervise the concrete implementation of the "three synchronizations". It is a crucial system for protecting the surrounding environment from the offshore methane hydrate platform.

The MEPL has particularly emphasized the necessity of applying the "three synchronizations" to oceanic projects. In accordance with Article 48, environmental protection facilities (of an oceanic project) must be designed, constructed, and utilized in conjunction with a project's main initiatives. Environmental protection facilities must obviously comply with the requirements made apparent by the project's specific EIA report (form).

The above-mentioned clause not only requires corporations to install the necessary environmental protection equipment in a dutiful manner, but also requires that the environmental protection agency enforces said requirements in a routine fashion, as well. Adequate environmental protection cannot fully rely upon the voluntary compliance of businesses, but rather requires the government to also play a key role in enforcing the appropriate instruments.

Both the MEPL and the 2018 Management Regulation on Preventing Pollution Damage of Marine Environment by Oceanic Project Construction (2018 MRPP) [30] have enabled local oceanic authorities to monitor and impose sanctions wherever a breach of agreement exists. These inspectors reserve the power to access all information relevant to environment protection, to enter into oceanic construction sites whenever and wherever needed, and to interrogate the heads of the various departments, if need be. (*See* Article 41, 2018 MRPP) Possible sanctions include fines, suspensions, and even criminal penalties. (*See* Chapter 7, 2018 MRPP) In general, public authorities are typically better equipped, as compared to their private counterparts, for exerting administrative power with the ultimate goal of protecting the environment.

3.3. Ex-Post Remedy—Environmental Tort Liability

This article now examines ex-post remedies, i.e., those remedies that are relevant once environmental damage has already occurred. Under the general principles of Chinese Tort Law (CTL) [31], whenever any harm is caused by environmental pollution, the polluter is held responsible under tort liability law, and therefore assumes the responsibility to compensate any affected victims [32]. In this case, the fault of the polluter is legally presumed, meaning they are "guilty until proven innocent" [33]. In this context, it is not the victims' responsibility to evidentially prove the fault of the polluter. Instead, it is the polluter's responsibility to prove their own innocence. Thus, if the polluter cannot prove their own innocence (or if the facts of the case never change when all facts are presented), they will be condemned to pay for all damages. In order to ensure that all victims are justifiably compensated for the damages they have suffered, Chinese tort law requires that the polluter prove that they, in fact, should not be held liable for the damages, or even that said liability has to be mitigated under certain circumstances under Chinese law (*See* Article 66, CTL). Thus, the victim is not liable for proving that the polluter(s) is guilty. Even if said pollution was triggered by a third party, the victim is still able to seek for compensation from the first alleged polluter. (*See* Chapter 8, CTL).

In this context, it is worthwhile to examine the discipline of the burden of proof. Chinese tort law (CTL) contains a special rule requiring the polluter to prove that "there is no causation between its conduct and the harm". Under the general principle of CTL, it is the claimant's responsibility to prove the casualty nexus, i.e., the "natural" link between an unlawful act and the damage. Contrarily, the CTL does, however, provide an exemption for certain environmental protection cases, mainly due to the difficulties for the accused to technically illustrate the nexus between the damages occurred and the polluter's conduct [34].

4. Technology for Extracting Offshore Methane Hydrates and Environmental Protection

When examining these new technologies for extracting offshore methane hydrates from a more concrete perspective, the reality is much more complex than the above illustrations reveal. It is worth noting, here, that there is indeed a huge gap between theory and practice—most of these laws and regulations do not specifically consider the inherent risks of the extraction processes of offshore methane hydrates. At the time said regulations and laws were drafted, advancements (and those risks) were not foreseeable. Therefore, it is necessary to scrutinize current environmental protection regulations in order to identify the existing loopholes.

4.1. The Certainty Issue: Assessing the Unknown

One of the greatest challenges of our societies—that have been defined "risks-societies" [35]—is, indeed, to prevent and manage risks, especially those connected with highly-dangerous (yet necessary)

activities. The task, indeed, is not only to sanction the damage, and to provide effective ways to compensate the victim, but to avoid as much as possible the occurrence of damages. Therefore, the emphasis here is placed in the moment before the beginning of the process. Technically, this risk assessing function is often performed by administrative law, and therefore by administrative agencies or organizations that often depends on state's power and ministries.

In the context of this analysis, for authorities, agencies and experts in charge of conducting EIAs, the largest problem lies in identifying the relevant information and knowledge regarding the process and outcomes of offshore MH extraction. Considering the offshore MH extraction process is still in its infancy, empirical studies are still ongoing and have not garnered enough information, as of this publication, sufficient for conducting precise evaluations [36]. Assessments are based on simulation models via experiments held in laboratories, rather than actual evidence gathered from real catastrophes. For this same reason (in the process of approving an environmental assessment report of offshore methane hydrate projects), the National Oceanic Bureau may not have enough experience or evidence to properly decide upon such a novel technology.

Moreover, the regulatory scope of an "environmental impact" is narrowly defined, and this represents a problem in assessing the cataclysmic risks generated from offshore MH extraction. The main scope of an environment impact assessment, as defined by the 2006 Management Regulation on Preventing Pollution Damage of Marine Environment by Oceanic Project Construction (2006 MRPP) [37], was limited to the "ocean environment" and "ocean resource". On the one hand, it is unlikely that hazards associated with MH extraction would attract the serious attention of China's policymakers because of its still-theoretical nature (as compared to practical experience). On the other hand, non-catastrophic hazards, such as the greenhouse effect—although significant, probably still would not significantly attract the attention of top-level officials, even with thorough consideration and evaluation.

Regarding the rules of an EIA, in detail, the assessment agency (hereinafter, the "agency") is not prepared enough to address the risks of offshore methane hydrate extraction. Under the Rule of Managing Oceanic Project Environment Impact Assessment (RMOPEIA) [38], the agency does not appear to have neither the expertise nor the sufficient knowledge necessary to evaluate the risks of offshore methane hydrate extraction for, at least, two reasons. First, Article 8 of the RMOPEIA simply requires that qualified agencies, those who offer assessment services for "general oceanic impact", should simply have their staffs trained and certified by the State Oceanic Administration. Thus, in examining the current training manual for certifying experts, there is no specific guidance related to assessing the risks of offshore methane hydrate extraction. Second, with regard to any consequential effects, the agency may lack references–or the scientific data–necessary to produce relevant evaluations of offshore MH processes. Article 9 of RMOPEIA simply indicates that the assessment's document's data must consider the aspects of the water quality, the sediment, the ecological currency, the geomorphology, and so forth. Unlike the data gathered from other natural resource development activities, that are generally available or easily collectable, the practice of offshore methane hydrate extraction is not fully implemented; therefore, related data has only just recently been collected or made available. Since offshore methane hydrate extraction has potentially wide-ranging impacts that may take decades to fully come to fruition, it is both time-consuming and costly to first gain, then collect, the data associated with this novel practice. However, at this present moment, it seems impossible to even collect such reliable data, because there are no practical examples of offshore MH extraction anywhere else around the world; thus, the only "reliable" evidence that may be gained comes only from "reliable" laboratory results. Therefore, it is extremely difficult—if not impossible—for an EIA report to be comprehensive without considering the specialized data stemming from the place where the project is either located or will have an anticipated impact.

Perhaps not feasible for the process at hand, public participation is another widely adopted legal tool crucial in fostering some sense of justice throughout the process of assessment and decision-making [39–41]. In particular, however, the RMOPEIA has very clearly made obvious

that a final assessment report should include the description of the process through which public participation was (mandatorily) included. (*See* Article 9, RMOPEIA.) However, public participation may complicate efforts to begin the MH extraction assessments and processes, as it may present far-reaching obstacles for many neighborhoods. Thus, the first (and perhaps most important) question that should be answered is: who, exactly, is "the public" for beginning such an assessment? First, the effects from MH extraction processes are, of course, of a transboundary nature, which could make it hard for jurisdictionally confined administrative departments to adequately gauge any potential effects. It is also unlikely that the very subject of an "offshore platform" has garnered very much interest from those, apart from the scientific research taskforce or platform workers, who would be willing to participate in such a process. Organizing the potentially affected public may pose a difficulty, because of both the cost and geographical barriers. Second, even if identified, the general public may not even have the sufficient knowledge needed to offer valuable suggestions. Since MH extraction technology is both novel and complex, it is very unlikely that there would even be any interest groups educationally equipped to offer informed suggestions and criticisms.

The very requirement of seeking prior approval from other central administrative bodies should surely improve the inclusiveness of a final decision yet is not sufficient without the local government's voice. Despite the fact that the 2006 MRPP has invited both Fishery and Armed Forces authorities to offer comments and insights on an environmental assessment's report, such insight still would not be inclusive enough without the comments of local government authorities. It is evident that, if there is an offshore MH extraction process under operation, the local authority is the first institution that will be alerted, and often has the upper-hand in collecting information regarding any inherent risks. Once an EIA report has been submitted to the Oceanic Administration, the question now asks as to whether or not current regulations can safeguard the extraction process. In accordance with the Procedure of Approving Environment Impact Assessment (PAEIA) [42], the relevant authority is responsible for forming an Approval Committee that must include the Oceanic Environment Protection Branch, the Legal Department, and the Inspection Team and the Oceanic Consultation Center. Upon a closer examination of the members included on the Approval Committee, it is obvious that technical specialists of the offshore MH extraction process are officially absent from the review process of an EIA report. Generally speaking, technical specialists are associated with scientific research bodies or the enterprises developing relevant technologies, but not with authorities. In most cases, authorities will invite technical specialists from their own list. Since the technology of methane extraction is novel, it is difficult to find experts on this area in the traditional list of specialists.

4.2. Monitoring Issue: Lack of Full Coverage

Although China has enacted a Technical Guidance on Tracking Environmental Impact of Maritime Project Construction (Technical Guidance) [43], and the Technical Norms Regarding Environmental Impact Assessment on Sea-Water Utilization Project [44], these regulations are far from sufficient for imposing any kind of adequate supervision of the sea environment. In particular, the Technical Guidance was issued in 2002—A time when offshore methane extraction technology was not yet developed. Consequently, the Technical Guidance should "technically" be considered outdated. The many drawbacks should, first, be considered and revised accordingly with regard to MH extraction technology. The main focuses of Technical Guidance include water quality, ecological system and deposits, but it does not cover the unorthodox factors, such as carbon emissions and ecological systems.

Even the Environmental Protection Agency has not yet placed the "construction of offshore MH extraction platforms" onto their full agenda. Under the "three synchronizations," as described in previous sections, environmental agencies are only responsible for checking as to whether the enacted environmental protection facility is in place and functional.

Moreover, even the Environmental Protection Agency may not have the necessary knowledge and insight for properly evaluating the outcome of such construction projects. Indeed, it is not formally required that the EIA report considers the construction process of offshore methane hydrate

installments—and this entails that, in the report, there are often omissions and gaps specifically regarding this aspect.

The 2006 MRPP has a restrictive list of wastes that must be exclusively discharged by the Oceanic Project; yet, the hydrate is not included on the list (*See* Chapter 4, 2006 MRPP). Therefore, unlike the wastes of crude oil that are closely regulated and monitored by the oceanic authority, the hydrates or CO_2 unleashed during extraction process of methane hydrate under is under no specific consideration of the law.

By taking into account the fact that offshore extraction platforms are often located in remote areas, the costs for physically inspecting and monitoring said construction processes could be problematic. Although, thanks to modern technology, long distance communication and inspection is now available; yet, the complexity and novelty of offshore MH extraction still requires close on-site scrutiny in order to ensure that risks are being addressed in effective manners. Also, said availability may also require these operations to update their facilities so as to enable the installations of the "best available technology." As already stressed, the environmental protection agency may be unable to monitor remote offshore operations because of the lack of enforcement resources and expertise [45]. Therefore, it is highly unlikely that the limited technological capacity of the environmental protection agency would be able to identify, and solve, the potential hazards stemming from offshore methane hydrate extraction projects, regardless of its budget problems or willingness to do so.

4.3. Remedy Issues: Inaccessibility to Justice

4.3.1. Information Asymmetry

In this section, the "reaction" of the legal system once the damage has occurred will be considered. As a matter of general concern, and as long as we are concerned with the rules of private law, the sanction (in a broader sense) is put upon the shoulders of the people who have been affected by the damage. This is commonly known as a "private enforcement" mechanism, by which the subjects damaged (both individually or in aggregate forms) can seek compensation by suing the polluting enterprise. Of course, this poses a number of problems—both of a theoretical and practical nature—that could render highly ineffective this mechanisms, related to the access to justice (i.e., the effective ability and the concrete capacity, assessed empirically, of people to seek redress for a wrong in a court of law) [46]. The aim of this section is to identify some of this problems, discuss them and provide a tentative solution where possible.

In the cases of offshore MH facilities and activities, information asymmetry refers to the fact that affected individuals may not possess the sufficient knowledge necessary for making accurate and rational decisions in identifying liabilities. On one hand, the tortfeasor may not be informed of the existence of such victims, or may even lack awareness regarding the extent of the damages caused by their own activities. On the other hand, victims may not have access to the information necessary to correctly identify the tortfeasor, or the accidents, that caused the damage in the first place.

This is particularly evident in the case at stake. In the process of offshore MH extraction, there exists the issue of information dispersal and processing. Dealing specifically with these issues, Roy Andrew Partain has identified two major concerns [6]. First, many potential victims may not even identify themselves as "victims" prior to an accident, as the actual radius of harm may be only vaguely determinable prior to an actual event. Secondly, some victims may not be able to decipher any scientific content, or the complex data, in order to gain an efficient understanding of potential risks. Thus, even if the information regarding risks and hazard is publicly made available, there are serious concerns that such information may not properly induce any kind of legitimate response from the public.

Lastly, victims may not be able to identify the actual tortfeasor. Since MH extraction occurs in offshore locations above the seabed, where there are no inhabitants, there is no convenient access for the surrounding public to monitor said activities; thus, there is a deep lacking of awareness regarding "triggering events." On their own accord, victims would have to even find the place where the harm

first occurred, then gain information using their own accessibilities. Such responsibilities would be hard for most individuals given the complex and fragmented nature of MH extraction incidents.

4.3.2. Absence of a Concrete Lawsuit Threat

In examining the second obstacle to truly effective liability rules, according to Steven Shavell, there are three primary sources of under-deterrence that could underpin a lacking lawsuit: (1) The existence of multiple plaintiffs; (2) a lack of evidence; and (3) missing parties [47–49]. What we clearly see here at play is the importance of the broader legal context, not only the one "made up" by rules, but also by practices as we find them in the concrete reality, in providing effective risks-management procedures [50]. Each factor is taken into account.

Regarding the first point, it should be understood that methane hydrate accidents are of very transboundary natures, and the harm caused from just one incident could entail numerous victims. Even if injured victims are entitled to gain monetary remediation for the harm, litigation costs against a very large corporation may be difficult to afford.

After a cataclysmic event (such as a seabed eruption or landslide), it is very likely that the direct evidence of the facts, that first triggered such harmful events, are immediately depleted. In general accidents of offshore MH extraction, as mentioned in the previous section, victims may lack the substantial information or evidence needed to sue the corporation. They may not even be able to collect the evidence necessary to support such a claim. Considering the complexity of offshore MH extraction pollutants, many scholars are highly skeptical that said victims are even able to detect their violated rights.

Furthermore, after certain catastrophes, some victims may have simply disappeared or, worse yet, died. As occurs during a tsunami event, entire seaside villages may be washed away. Also, measurable damages may only begin to produce its effects years, or even decades, after the extraction process has been completed or the facilities have been abandoned. Few companies are likely to remain operative for that long, as field assets are constantly bought and sold. Corporations working in this field are subjected to the same market forces as are all other major corporations: they are bought, merged, and dismissed over their lifetime. Likewise, victims also move in and out of the impacted areas as years go by.

4.3.3. Insolvency Risks

Lastly, and often, insolvency laws frustrate the rules of civil liability, because they limit the impact of negative financial incentives. Even more specifically, insolvency may pose a problem even if the tortfeasors are detected, prosecuted, and finally judged; they would still avoid the consequences of their responsibility simply because they do not possess the sufficient capital, nor the assets, to pay the fines imposed. When the tortfeasor is insolvent or underfunded, they may escape the consequences of their financial liability. Given this fact, insolvent tortfeasors have no economic incentives that would sway them to impose practical and sufficient levels of precaution thus avoiding accidents. Therefore, individuals may deliberately declare themselves only private limited company (Ltd.) to limit the consequences of potential actions. Limited liability, for certain forms of business associations, can therefore frustrate the functional purposes of liability rules [48]. All corporations, in essence, pose this type of insolvency risk [51].

However, given the fact that the harm caused by offshore MH extraction can be of catastrophic proportion, it may not be feasible for private companies to fork the cost all under their own will. Under China's current legal framework, there are no mandatory requirements for MH extraction platforms to sign civil liability insurance contracts, and this poses a problem that, itself, should be fixed. For conventional natural resource development, it could be challenging to obtain active civil liability contracts. For instance, Article 26 of the 2018 MRPP states: "Oceanic oil and gas extraction entity shall acquire civil liability insurance for pollution." However, companies working on offshore MH extraction

are not obliged to sign any civil liability insurance schemes. Furthermore, major Chinese insurance companies do not even provide such insurance contracts that cover the damages of MH extraction.

5. Adopting Additional Measures and Reinforcement Mechanisms to Protect the Environment

In order to ensure that environmental issues are carefully considered during the process of offshore MH extraction, additional measures and reinforcement mechanisms should be imposed for each of the three areas described above.

5.1. Strengthening the Environmental Impact Assessment

In sum, in the cases described here, it is crucial to consider the broader environmental perspectives in establishing sufficient EIAs. First of all, many factors must be added to the list of considerations, such as carbon emissions. Second, it is necessary to look at longer terms and wider ranges of observation before approving technical standards under an EIA.

Lastly, it is necessary to expand access to the public in order to enable the participation of private entities, too. Indeed, if public bodies or institutions are less likely to possess the capacity to process and decode the technological or scientific data of a risky activity, then private bodies may be able to provide such beneficial information [52]. Since the technology of offshore MH operations are expected to rapidly advance, private actors who are engaged in such technological development could helpfully assist in setting the standards to be met according to the "most available" scientific information.

5.2. Reinforcing the Monitoring System

Since it is the corporation that owns the offshore MH platform controlling most of the technology and data, it is necessary to establish powerful mechanisms of internal control rather than passively relying upon external inspections. These corporations should, therefore, demonstrate that their own internal control is effective while making essential data available to stakeholders in order to improve both transparency and public scrutiny{Citation}. These corporations should thus be held liable whenever there is no such mechanism, even if no damage has yet occurred. Conversely, the compliance of internal control practices or transparency rules can represent a factor that could mitigate tort liability of the offshore methane hydrate extraction company, in the case of an accident.

As stressed in the previous sections, in order to make administrative procedures more effective, private bodies and entities should be included in the control processes, as well. In China, as in the rest of world, there are many NGOs and interest groups that focus and work on environmental issues [53]. In some cases, these groups have developed their own channels to effectively access all information and expertise needed to deeply analyze the impacts of environmental pollution [54]. Therefore, allowing NGOs and interest groups to assist public entities may also prove helpful in overcoming the lacking knowledge and resources of public administrative agencies [54].

5.3. Expanding the Toolbox of Tort Law

In order to ensure that the victims are able to access effective remedies, and to build an efficient system of civil liability in the cases here at stake, a threefold approach should be adopted.

First, it is highly recommended to establish a mandatory insurance system so as to reduce the risk of insolvency. As emphasized before, current offshore methane extraction is not subjected to any insurance coverage, and not yet even made available by insurance corporations. Therefore, it is rather urgent to mandate that insurance companies provide an insurance scheme that could be applied in such cases. However, it is not surprising that insurance companies are reluctant to provide such a scheme, given the fact that the proportion, or even the possibility of the risks connected to MH extraction, lack any statistical correlation. In order to overcome such a challenge, the government themselves could provide some kind of insurance directly to the corporations as a kind of "reassurance" to insurance companies, so as to encourage insurance companies to perhaps "test the waters."

Second, public authorities should be proactively processing and releasing relevant data for public scrutiny. To solve the issue of "information asymmetry", Professor Partain has suggested the involvement of these regulatory bodies as well [7]. A regulatory body, here, refers to an administrative institution in charge of supervising offshore MH projects. As such, this regulatory body generally stores firsthand data while fulfilling supervisory roles, and therefore can re-balance information asymmetries. In addition, a regulatory body can facilitate disputes whenever lawsuits are unlikely to be heard in court, through unifying and financing the multiple and fragmented victims. Additionally, a regulatory body may also be able to decide the claims by itself, e.g., through administrative courts, and also by providing a due process of law that may otherwise be lacking.

Lastly, it is necessary to provide forms of strict liability rules in order to make access to justice a little easier, even if, on the other hand, this regime could de-incentivize the entrepreneurial activity (if companies are obliged to recover damages independently from their negligence, they might avoid investing in this sector). Strict liability requires tortfeasors be made available to adequate incentives for risk management, as contrasted by the limited incentives provided by public regulation [55] (p. 129). In connection with offshore MH extraction processes, applying strict liability can ensure that developers and operators impose concrete self-control mechanisms in controlling rather preventable risks.

6. Conclusions

In conclusion, although the commercial development of offshore MH seems economically promising, there are indeed risks that should not be underemphasized, or simply ignored, by the relevant legal framework [4,50], especially regarding oceanic life and the hazards that could affect vast areas along a coastline.

China's environmental and remediation rules are far from effective in preventing, or compensating for, the potential environmental harm triggered by the offshore MH extraction. In particular, traditional instruments including EIAs, the three synchronizations system, and civil liability rules (i.e., ex ante, ongoing, and post ante forms of protection for the environment) should consider offshore MH extraction under the lens presented through this article.

To ensure the sustainability of offshore MH extraction, China must update its current environmental protection and remediation rules, and adapt said rules to the new industrial technology. Accordingly, the three aspects that have been illustrated, including public participation, administrative/public scrutiny, and economic compensation, should be improved by specifically addressing the risks and hazards associated with offshore methane hydrate extraction.

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