BRILL
NIJHOFF

THE INTERNATIONAL JOURNAL OF
MARINE AND COASTAL LAW 35 (2020) 1–34

THE INTERNATIONAL JOURNAL OF MARINE AND COASTAL LAW

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The Exploitation of Oceanic Methane Hydrate: Legal Issues and Implications for China

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Abstract

With the growth of global energy demand, States are actively considering the exploration for new energy. Methane hydrate is one of the world's new energy sources with high energy density and abundant reserves, which have great strategic significance. This article focuses on three aspects, namely, project preparation, risk prevention and accident management, and addresses the risk issues arising from the exploration of methane hydrate. It is important to apply the United Nations Convention on the Law of the Sea and other treaties, as well as customary international law, while examining the rules applicable to the exploration of methane hydrate. State practice such as those of the United States, Russia, Japan, the European Union and China, are also discussed. The article puts forward some suggestions on the development of China's methane hydrate resources. The core objective is to achieve a balanced approach to the development of environmental protection and energy development.

Keywords

methane hydrate – risk prevention – transboundary environmental impact – environmental impact assessment

Introduction

Economic development has kept pace with energy demand; thus States have been looking for alternative energy sources. Methane hydrate is one such potential source. Also known as methane clathrate, methane hydrate is a solid clathrate compound, formed from methane and water under appropriate

 | DOI:10.1163/15718085-BJA10003

conditions (e.g., temperature, pressure and pH levels). The compound may break down to release methane (>90%), and is colloquially referred to as 'flammable ice'.[1] Methane hydrate deposits are mainly found in two types of environment, namely, permafrost regions and on ocean floors,[2] hence, their categorisation as continental methane hydrate and oceanic methane hydrate respectively. Methane hydrate is an ideal alternative to fossil fuels, given its extensive worldwide distribution and clean nature during utilisation.[3] As a new energy for humankind and its potential contribution to future global energy development,[4] research and exploration for methane hydrate have attracted increasing consideration.

In recent years, the global energy market has witnessed increased energy demand from high-growth developing countries such as China and India and a shift to cleaner, low-carbon emission energy sources.[5] In China, exploration for and development of methane hydrate is of particular importance. Firstly, exploration could lead to discovery of a valuable supply of energy, which would reduce reliance on expensive energy imports and help it move toward energy self-sufficiency. Secondly, States along the '21st Century Maritime Silk Road Initiative' as proposed by China, are rich in methane hydrate-bearing layers, accounting for over 90 per cent of all known methane hydrate reserves,[6] and many of them have a strong demand for energy. Since China already possesses appropriate mining technology and equipment, it could facilitate resolution of energy shortages in these States, promote their economic development and integration, and push forward implementation of the 'Belt and Road Initiative'.[7] Thirdly, it is highly likely that methane hydrate will become industrially

1 The field work for this article is supported by the following project: The National Social Science Fundamental Project, China, 'Research on China's Maritime Rights Protection under the Perspective of Maritime Community with the Shared Future' (Grant No. 19VHQ009). Z Haifeng, L Haibin, and T Fangzheng, 'Research and development prospect of natural gas hydrate' (2016) 4 *Liaoning Chemical Industry* 533–535, at p. 533 (in Chinese).

2 Office of Fossil Energy, 'Methane hydrate' available at https://www.energy.gov/fe/science-innovation/oil-gas-research/methane-hydrate; accessed 1 January 2020.

3 Haifeng, Haibin, and Fangzheng (n 1), at p. 533.

4 Guangzhou Marine Geological Survey of China Geological Survey, 'Methane Hydrate Prospecting and Development in the South China Sea Forum held in Guangzhou' available at http://www.gmgs.cgs.gov.cn/dwdt_4358/201712/t20171225_447877.html; accessed 20 August 2018 (in Chinese).

5 BP, 'BP statistical review of world energy 2017' available at https://www.bp.com/zh_cn/china/reports-and-publications/_bp_2017-_.html; accessed 20 August 2018.

6 Y Yu and Y-C Chang, 'The 'One Belt One Road' Initiative and its impact on shipping law in China' 87 (2018) *Marine Policy* 291–294, at p. 291.

7 Q Dongzhou, 'Reflections on the hot topic of methane hydrate' (2017) 3 *Marine Equipment/Materials and Marketing* 14–16, at p. 16 (in Chinese).

necessary in order to stabilise the exchange rate of the renminbi (RMB). As such, methane hydrate exploration, technology development and subsequent successful exploitation would be a great advantage for the internationalisation of the RMB.[8]

China initiated its methane hydrate research and exploration projects in 2002. The Notice of the General Office of the State Council on Issuing the Programme of Action for the Energy Development Strategy (2014–2020) noted the need for

> [p]roactive promotion of natural gas hydrate resources exploration and assessment: Efforts for tackling difficult problems in technology for natural gas hydrate exploration and development should be strengthened, and core technology with self-owned intellectual property rights, should be fostered with active promotion of projects of trial exploitation.[9]

On 24 August 2017, the Ministry of Land and Resources, the Government of Guangdong Province and the China National Petroleum Corporation entered into the Strategic Cooperation Agreement on Promoting the Construction of the Methane Hydrate Exploration and Exploitation Pilot Zone in the Shenhu area of the South China Sea.[10] After nearly twenty years of work, China made a historic breakthrough, realising indigenous innovation in the theoretical, technological, engineering and equipment aspects of methane hydrate exploration and exploitation.[11] To date, China has discovered significant potential methane hydrate reserves in the South China Sea and the East China Sea and on the Qinghai-Tibet Plateau. The estimated reserves in the South China Sea could be

8 Sohu.com, 'Methane hydrate vs shale gas: A US–China energy war on the verge' available at http://www.sohu.com/a/151082585_759542; accessed 20 January 2020 (in Chinese).

9 State Council of China, *The Notice of the General Office of the State Council on Issuing the Programme of Action for the Energy Development Strategy (2014–2020)*, (2014) No. 31 (in Chinese, translation by author).

10 Ministry of Natural Resources, 'Ministry of Natural Resources, the Ministry of Land and Resources, the Government of Guangdong Province, and the China National Petroleum Corporation entered into the Strategic Cooperation Agreement on Promoting the Construction of the Methane Hydrate Exploration and Exploitation Pilot Zone in the Shenhu Area, South China Sea' available at http://www.mlr.gov.cn/xwdt/jrxw/201708/t20170826_1578386.htm; accessed 20 January 2020 (in Chinese).

11 *People.cn*, 'China's pilot methane hydrate mining achieves historic breakthrough' available at http://scitech.people.com.cn/n1/2017/0518/c1007-29284894.html; accessed 20 January 2020 (in Chinese).

as large as 70 billion tonnes of oil equivalent (toe).[12] In 2017, methane hydrate was approved by the State Council as the 173rd recognised mineral with economic potential.[13] In the same year, the Notice of the Ministry of Science and Technology on Approval of the Construction of Two State-level Key Enterprise Laboratories of Methane Hydrate and Cognitive Intelligence provided for construction of State-level laboratories by the China National Offshore Oil Corporation Research Institute that focus on the strategic emerging methane hydrate industry and aim to develop leading technology for the industry.

Given the rapid expansion of methane hydrate exploration, the mineral deserves more attention as it has the potential to be an alternative to oil, natural gas and other traditional energy sources. The exploration for and exploitation of methane hydrate, however, also faces challenges that must be addressed: the methane hydrate legal framework is still in its infancy, with no specific legal regulations, precautionary measures or dispute settlement mechanisms to cope with the accompanying environmental and production risks. In addition, methane hydrate exploitation is closely associated with water resource, climate change and energy issues. As such, questions arise as to how to coordinate methane hydrate exploitation and environmental protection with promotion of commercial development of methane hydrate.

Risks Associated with Methane Hydrate Exploration and Exploitation

Environmental Risks

Aggravation of Climate Change

Despite methane hydrate being an ideal green energy source with a high combustion value,[14] methane is a greenhouse gas that, according to the Intergovernmental Panel on Climate Change (IPCC), is twenty-five times more powerful than carbon dioxide[15] and, as such, its exploitation may further exac-

12 Shao Zhongni, 'Resources distribution of gas hydrate and its exploration and development advances' (2007) 5 *Contemporary Petroleum and Petrochemical* 24, at p. 26 (in Chinese).

13 Ministry of Natural Resources, 'Methane hydrate becomes the 173rd recognised mineral in China: Three considerations' available at http://www.mlr.gov.cn/xwdt/mtsy/zgxww/201711/t20171120_1676372.htm; accessed 20 January 2020 (in Chinese).

14 Dongzhou (n 7), at p. 15.

15 Intergovernmental Panel on Climate Change, 'Landmark United in Science report informs Climate Action Summit, New York', 22 September 2019, available at https://www.ipcc.ch/2019/09/22/united-in-science-report-climate-summit/; accessed 16 January 2020.

erbate climate change. It is calculated that the methane contained in methane hydrate is 3,000 times the volume of the methane in the atmosphere.[16] The current technology cannot ensure complete sealing of the hydrate during exploitation operations as changes in pressure and temperature may cause it to break down and release methane into the atmosphere, thereby intensifying the greenhouse effect.[17] In addition, methane may transform into carbon dioxide, another greenhouse gas that may adversely have an impact on marine industries (fisheries and tourism) and marine life, and possibly accelerate climate change.

Destruction of Biodiversity

According to the 2016 Geological Survey Report of China, the largest cold seep plume was found in the Shenhu area of the South China Sea.[18] Methane also exists in significant quantities in this area. It was observed that the ecosystem of the Haima cold seep contains various species, which suggests that the surrounding environment had a large amount of methane hydrate breakdown. Large-scale exploitation of methane hydrate is likely to have affected cold seep ecosystems. Furthermore, if the exploitation technology is not sufficiently advanced, it is highly likely that a methane leak could result in the death of fish and marine mammals, disturbing the ecological balance in the surrounding environment.[19] Unsustainable exploitation of methane hydrate, thus, has a negative impact on biodiversity.

Unexpected Geological Impacts

Taking polar and seafloor gas hydrates as an example, polar methane hydrate is a metastable compound in permafrost regions and on the ocean floor. The breakdown of polar methane produces large amounts of free gas, increasing the pore pressure of the sedimentary layer and lowering the cementing strength of the ocean floor. As a result, the sedimentary layer's shear strength and bearing capacity become compromised, leading to an increased possibility of landslide and strata collapse of the ocean floor.[20] In China, continental

16 L Guangzhi, 'Natural gas hydrate (GH): The future energy resource and its prospecting and development difficulties' (2005) 5 *Chinese Journal of Nature* 258–263, at p. 261 (in Chinese).

17 Haifeng, Haibin, and Fangzheng (n 1), at p. 535.

18 China Geological Survey, *2016 Geological Survey Report of China* (Beijing: 2017), at p. 163.

19 Y Song , L Yang, J Zhao *et al.*, 'The status of natural gas hydrate research in China: A review' (2014) 31 *Renewable and Sustainable Energy Reviews* 778–791, at p. 789.

20 W Pingkang, Z Youhai, Z Yue *et al.*, 'Polar gas hydrate exploration and development' (2014) 4 *Chinese Journal of Polar Research* 502–514, at p. 511 (in Chinese).

methane hydrate is mainly found in the ecologically vulnerable Qinghai-Tibet Plateau tundra and its exploitation could have negative impacts on the tundra[21] and lead to geological changes. In the South China Sea, exploitation of oceanic methane hydrate could cause ocean floor instability or even underwater mudslides. Submarine installations in the immediate area, such as submarine pipelines and communication cables could be destroyed, resulting in property losses.

Environmental Disputes

As a recognised mineral, exploitation of methane hydrate could harm private and collective environmental rights, such as those related to water resources and climate change. Prevention and settlement of environmental disputes and attribution of liability are issues that must be dealt with. Future commercial exploitation of methane hydrate resources may also result in transboundary environmental damage, which would require the application of conventional and customary rules of international environmental law and the law of the sea.

Risks Related to Commercial Exploitation

Intensified Ownership Disputes

Methane hydrate is widely distributed underground, therefore, if sovereignty over the land or sea is unclear, ownership of the methane hydrate may also be disputed. The fact that methane hydrate is an important alternative energy source has the potential to trigger more or to intensify existing disputes. For example, there are large methane hydrate reserves in the South China Sea. Given the ongoing sovereignty disputes in the region, ownership of the methane hydrate could well further exacerbate the tension.[22] The Arctic States, such as the United States, Canada and the Russian Federation, have all increased their investment in exploration and research of Arctic methane hydrate within their respected territories.[23] Given the unclear sovereignty status over the Arctic and its rich methane hydrate resources, intensified ownership disputes seem inevitable with the advancement of methane hydrate exploitation technology.[24]

21 F Yarong, 'Research status of combustible ice and the bottleneck of its commercial exploitation' (2018) 1 *Oil Drilling and Production Technology* 68–80, at p. 79 (in Chinese).

22 XW Wang and Y-C Chang, '"Sea Law Phalanx" initiative: Conference report' (2016) 72 *Marine Policy* 11–13.

23 Pingkang, Youhai, Yue *et al.* (n 20), at p. 503.

24 Y-C Chang, 'The Sino-Canadian exchange on the Arctic: Conference report' (2019) 99 *Marine Policy* 76–79.

Cost Risks

Currently, the mining of 1 cubic metre of methane clathrate costs as much as 200 USD. Generally, 1 cubic metre of methane clathrate releases about 164 cubic metres of gas, meaning that, gas mined in this way costs over 1 USD/m^3, which is much higher than gas that is produced through regular methods.[25] This is why governments are the major players in methane hydrate exploration, with only limited participation of private corporations. The rise of shale oil extraction has brought the oil industry back to the land. The resulting low oil price has rendered offshore oil drilling less profitable. Similarly, as an unconventional resource distributed on the ocean floor and plateaus, high costs are associated with methane hydrate mining, which might discourage short-term widespread commercial involvement.[26] If technology is not sufficiently advanced to reduce mining costs to an economically viable level, then commercial utilisation of methane hydrate would require governmental subsidies, as is the case with a number of other forms of renewable energy.[27] High extraction costs could, therefore, hinder the exploitation of methane hydrate resources.

The Application of International Law

As methane hydrate exploitation is insufficiently mature to encourage industrial production, there has been little pressure to create a specialised international legal regime governing this issue. Nonetheless, international treaties that deal with nature resources could be applicable to methane hydrate exploitation. For example, the United Nations Convention on the Law of the Sea (LOSC) contains provisions on exploitation of marine minerals.[28] Recognising methane hydrate as a mineral would mean that the LOSC would be applicable to exploitation of oceanic methane hydrate.

Methane hydrate is a mineral resource by its nature, and the potential environmental risks are a primary consideration during its exploitation.[29] Environmental issues are also the focus of several international treaties. This

25 W Erde and H Jia, 'Over 30 countries and regions into methane hydrate and 4 challenges against commercialization' available at http://tech.sina.com.cn/d/i/2017-05-22/doc-ifyfkqwe0518787.shtml; accessed 20 January 2020 (in Chinese).

26 Dongzhou (n 7), at p. 15.

27 This does not apply to wind or solar which are cheaper than oil.

28 United Nations Convention on the Law of the Sea (Montego Bay, 10 December 1982, in force 16 November 1994) 1833 *UNTS* 397 [LOSC].

29 Y-C Chang and N Wang, 'Legal system for the development of marine renewable energy in China' (2017) 75 *Renewable and Sustainable Energy Reviews* 192–196.

section will first provide an overview of international law on energy and mineral resources and then discuss international rules regarding selected environmental topics that are applicable to methane hydrate.

International Law Regarding Energy Exploitation

In 1962, the United Nations General Assembly adopted the 'Permanent Sovereignty over Natural Resources' resolution,[30] officially confirming States' permanent sovereignty over their natural wealth and resources.[31] As a mineral resource, methane hydrate belongs to the State in which it is located. The 2015 International Energy Charter,[32] with eighty-eight signatories, is a major international instrument that strengthens energy cooperation and security between parties.[33] The difficulties and technological barriers to industrial-scale methane hydrate exploitation may require States' cooperation. The International Energy Charter provides guidance to States on reaching a balance between energy security, economic development and environmental protection.

With an aim of regulating marine non-living resource exploitation and environmental protection, the LOSC establishes exploitation and protection frameworks for such resources located in the territorial sea, the exclusive economic zone, the continental shelf and the Area. A coastal State has sovereignty over its territorial sea and accordingly, enjoys undisputable title to methane hydrate resources located therein and may conduct exploitation operations. Article 56(1) of the LOSC provides that, in the exclusive economic zone, the coastal State has 'sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds'. The coastal State therefore has jurisdiction over methane hydrate located in its exclusive economic zone and may exploit them without other States' interference. Moreover, according to Article 77 of the LOSC,[34] the coastal State

30 United Nations General Assembly, 'Permanent Sovereignty over Natural Resources', UN Doc A/RES/1803(XVII) (14 December 1962).

31 H Zhenzhong, 'International energy law: Characteristics and attributive position' (2014) 1 *Journal of Beijing Normal University* (*Social Science Edition*) 134–139, at p. 134 (in Chinese).

32 International Energy Charter, available at https://energycharter.org/fileadmin/DocumentsMedia/Legal/IEC_EN.pdf; accessed 20 January 2020.

33 Y-C Chang, 'The legal constraints and the opportunities of a global energy network: Chinese perspectives' (2017) 9(5) *Journal of World Energy Law and Business* 79–90.

34 LOSC (n 28), Article 77: Rights of the coastal State over the continental shelf: '1. The coastal State exercises over the continental shelf sovereign rights for the purpose of exploring it and exploiting its natural resources. 2. The rights referred to in paragraph 1 are exclusive in the sense that if the coastal State does not explore the continental shelf or exploit its

exercises sovereign rights over the continental shelf for the purpose of exploring and exploiting resources such as methane hydrate and such rights are exclusive in nature.[35]

The Area is the seabed and ocean floor and subsoil thereof beyond the limits of national jurisdiction.[36] It is noteworthy that one of the main issues for offshore oil and gas exploitation on the outer continental shelf (beyond 200 nautical miles) is that there are no global standards in place, and any such standards potentially conflict with the regime of the high seas. Methane hydrate deposits located within the Area are not subject to the jurisdiction of any coastal State, but are the common heritage of mankind and are regulated by the International Seabed Authority. Thus, exploitation operations may only be undertaken on condition of effective protection of the marine environment.[37] Given the environmental risks inherent in mining methane hydrate, exploitation should be conducted in accordance with the LOSC, with environmental protection taking priority. Annex III of the LOSC provides for basic conditions for the prospecting, exploration and exploitation of minerals, including methane hydrate, in the Area. While encouraging prospecting in the Area,[38] Annex III also sets out strict conditions: the applicant (contractor) must be sponsored by the State Party of which it is a national. The sponsoring State has the responsibility to ensure that the sponsored contractor carries out activities in the Area in conformity with its obligations under the LOSC and the terms of its contract. Failing that, the sponsoring State will be liable for any damages caused by the failure of the sponsored contractor to comply with its obligations.[39] The liability shall be for the actual amount of damage caused.[40]

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natural resources, no one may undertake these activities without the express consent of the coastal State. 3. The rights of the coastal State over the continental shelf do not depend on occupation, effective or notional, or on any express proclamation. 4. The natural resources referred to in this Part consist of the mineral and other non-living resources of the seabed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil'.

35 Y-C Chang, 'Marine renewable energy: The essential legal considerations' (2015) 8(1) *Journal of World Energy Law and Business* 26–44.

36 LOSC (n 28), Article 1(1).

37 *Ibid*., Article 145.

38 *Ibid*., Annex III, Article 2.

39 See also the Responsibilities and Obligations of States with Respect to Activities in the Area, Advisory Opinion, 1 February 2011, ITLOS Reports 2011, p. 10; D Freestone, 'Responsibilities and obligations of States sponsoring persons and entities with respect to activities in the Area' (2011) 105 *American Journal of International Law* 755–761.

40 LOSC (n 28), Annex III, Article 22.

However, Annex III of the LOSC does not deal with all the issues regarding exploration and exploitation methane hydrate, for example, provisions concerning the size of Areas to be exploited. The International Seabed Authority will have to develop more detailed regulations should methane hydrate exploitation be pursued in the Area, as has been done for other mineral resources such as polymetallic nodules, sulphides and cobalt crusts.

International Law Regarding Climate Change

Exploitation of methane hydrate may exacerbate the greenhouse effect, which would incur the application of international climate change treaties. These multilateral treaties include the 1992 United Nations Framework Convention on Climate Change (UNFCCC),[41] its 1997 Kyoto Protocol[42] and the 2015 Paris Agreement.[43] While the first two instruments adopt a common but differentiated responsibilities approach that emphasises emissions reduction by developed countries, the 2015 Paris Agreement attaches more importance to the intended nationally determined contributions (INDC) that reflect the reduction level capacity and willingness of the committing State.[44]

If a State that possesses methane hydrate reserves is a Party to the UNFCCC, then the greenhouse gas emissions resulting from methane hydrate exploitation should be included in the amount of the State's overall carbon emission and operational plans.[45] Moreover, relevant domestic legislation must also consider emission reduction requirements. By way of contrast, the Paris Agreement allows for voluntarily Nationally Determined Contributions (NDCs), meaning that, the Parties decide the size and form of emissions reductions, on the basis of their capacity and willingness to make reductions.[46] The voluntary nature of emission reduction plans may, on the one hand, facilitate methane hydrate exploitation and increase the scale of exploitation; on the other hand, it raises concerns about emission reductions being secondary to resource exploitation due to the lack of a compulsory reduction amount. To cope with such concerns, the Paris Agreement also establishes the Parties'

41 United Nations Framework Convention on Climate Change (Rio de Janeiro, 3 June 1992, in force 21 March 1994) 1771 *UNTS* 107 [UNFCCC].

42 Kyoto Protocol to the United Nations Convention on Climate Change (Kyoto, 16 March 1998, in force 16 February 2005) 23 *UNTS* 162.

43 Paris Agreement to the United Nations Convention on Climate Change (Paris, 12 December 2015, in force 4 November 2016) TIAS No. 16-1104.

44 H Jingjing, 'From Kyoto Protocol to Paris Agreement: The start of a new climate governance age' (2016) 3 *Chinese Review of International Law* 77–88, at p. 78 (in Chinese).

45 UNFCCC (n 41), Article 3.

46 Jingjing (n 44), at p. 81.

reporting obligations in the hope that a Party will consider its reputation and environmental needs and try to strike a balance between resource exploitation and emissions reduction. The bottom line is that methane hydrate should not be exploited at the expense of the environment. All necessary emission calculations and precautions must be conducted during the preparatory phase in order to response to the UNFCCC and the Paris Agreement requirements.[47]

International Law Regarding Transboundary Environmental Damage

Methane hydrate exploitation may result in transboundary pollution that not only harms the exploiting State, but also causes physical injuries and property damage to foreign States or persons. In such cases, the application of international law is warranted. Marine pollution incidents occurring during exploitation of oceanic methane hydrate would be a major concern.[48]

In terms of environmental damage prevention, Article 194(3) of the LOSC provides that

> [t]he measures taken pursuant to this Part shall deal with all sources of pollution of the marine environment. These measures shall include, *inter alia*, those designed to minimise to the fullest possible extent: … (b) pollution from vessels, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, preventing intentional and unintentional discharges, and regulating the design, construction, equipment, operation and manning of vessels; (c) pollution from installations and devices used in exploration or exploitation of the natural resources of the seabed and subsoil, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment, operation and manning of such installations or devices.

As marine methane hydrate is mainly found on the seabed, exploitation operations would inevitably involve the use of drilling equipment, such as drilling rigs, platforms and vessels. The LOSC is, therefore, applicable concerning the prevention of pollution by vessels and related infrastructure.

47 N Wang and Y-C Chang, 'Effectiveness of low-carbon governance implementation in China' (2018) 17(3) *Environmental Engineering and Management Journal* 601–609.

48 Y-C Chang and Y Zhao, 'The Fukushima nuclear power station incident and marine pollution' (2012) 64(5) *Marine Pollution Bulletin* 897–901.

Article 199 of the LOSC provides that

> [i]n the cases referred to in Article 198, States in the area affected, in accordance with their capabilities, and the competent international organisations shall cooperate, to the extent possible, in eliminating the effects of pollution and preventing or minimising the damage. To this end, States shall jointly develop and promote contingency plans for responding to pollution incidents in the marine environment.

As a result, as part of the preparatory work for oceanic methane hydrate exploitation, a State must take precautionary measures against marine pollution. If the operations area is adjacent to another State or is subject to dispute, the relevant States must engage in dialogue and negotiation to ensure that exploitation is undertaken in compliance with their environmental protection responsibilities.[49]

The international community also has established a set of universally applicable principles of international environmental law that should be used as guidance for future methane hydrate exploitation. For example, the *Trail Smelter Arbitration* case[50] established that no State can use their territories in such a way that would cause harm by air pollution to another territory, which in a sense supports strict liability for environmental damage.[51] As such, in the event of environmental damage caused by methane hydrate exploitation operations, the exploiting State should abide by this guidance and prevent damage to other States. Failing this, the State is liable for the damages caused to States and their citizens, even if there is no violation of its international obligations.[52]

Despite the guidance found in international treaties, customary international law and international law cases, transboundary environmental damage cases have never overcome the difficulty of drafting unified rules for causal relationships. For example, submarine earthquakes and tsunamis may injure an infinite number of people. As the harm is indirectly inflicted through action of the seismic event and the reaction of the sea, the victims usually lack standing in seeking remedies, due to the absence of a direct causal relationship.[53]

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49 Y-C Chang, W Gullett and DL Fluharty, 'Marine environmental governance networks and approaches: Conference report' (2014) 46 *Marine Policy* 192–196.

50 *Trail Smelter Arbitration* (*United States* v. *Canada*) (1941) 3 *RIAA* 1905–1982.

51 *Ibid*., pp. 1963–1965.

52 G Palmer, 'New ways to make international environmental law' (1992) 86(2) *American Journal of International Law* 259–283, at p. 265.

53 L Jiayi, *Study of International Oil Spill Cases and Legal Mechanism of State Claim on Marine Ecological Damage* (China Ocean Press, 2010) at p. 148 (in Chinese).

Given the wide scope and indirectness of transboundary damage that could be caused by methane hydrate exploitation, it may be difficult to determine the causal relationship between the exploitation and any resulting environmental damage or personal harm. As a result, environmental damage claims resulting from methane hydrate exploitation incidents may be very difficult to litigate.

In response, some States have transferred the burden of proof or adopted lower evidentiary requirements in environmental damage cases in the realisation that when a large number of people are exposed to the same environmental hazard, individualised causal relationships are very difficult to prove.[54] Other States shift the burden of proof to the polluter, requiring the latter to prove the nonexistence of a causal relationship between its activities and the damage.[55] Establishing transboundary environmental damage responsibility may be dealt with by drawing reference from case law, theories and domestic practice.

International Law Regarding Biodiversity Protection

Biodiversity risks are mainly associated with oceanic methane hydrate exploitation, for which both the Convention on Biological Diversity (CBD)[56] and the LOSC contain applicable legal norms. Entering into force in 1993, the CBD currently has 193 Contracting Parties and contains provisions on the prevention and handling of biodiversity loss incidents, including transboundary issues. Article 3 of the CBD makes it clear that States have the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or areas beyond the limits of national jurisdiction. Article 8, entitled 'In-situ Conservation', encourages Contracting Parties to establish a system of protected areas or areas to regulate or manage biological resources. Article 10 suggests that Contracting Parties integrate consideration of the conservation and sustainable use of biological resources into national decision-making, and encourages cooperation between a Contracting Party's governmental authorities and its private sector to develop methods for sustainable use of biological resources. Article 14 encourages Contracting Parties

54 RV Percival (Y Zhaoxia and H Jing (trans.)), 'Liability for environmental harm and emerging global environmental law' (2016) 3 *Journal of Jishou University* (*Social Science*) 1–11, at p. 3 (in Chinese).

55 Tort Law of the People's Republic of China, Article 66: 'Where any dispute arises over an environmental pollution [incident], the polluter shall assume the burden to prove that it should not be liable or its liability could be mitigated under certain circumstances as provided for by law or to prove that there is no causation between its conduct and the harm'.

56 Convention on Biological Diversity (Rio de Janeiro, 5 June 1992, in force 29 December 1993) 1760 *UNTS* 79.

to introduce procedures that require environmental impact assessment of proposed projects that are likely to have significant adverse effects on biological diversity, with a view to avoiding or minimising such effects. Article 22 makes it clear that the provisions of the CBD will not affect the rights and obligations of any Contracting Party derived from any existing international agreement, except where the exercise of those rights and obligations would cause serious damage or threat to biological diversity.

These provisions demonstrate the need for precautionary arrangements before the onset of a methane hydrate project: environmental impact, extraterritorial environmental impact, and biodiversity distribution, must all be assessed or surveyed, so as to minimise adverse effects on biological diversity. If the project is located in an environmentally vulnerable region, where exploitation would likely result in severe loss of biodiversity, then the region should become a protected area, rather than an exploitation site. Where proper measures have been taken and an exploitation project is considered viable, the government should incorporate a biology resources protection clause in the exploitation contract so as to maximise biodiversity protection. Nonetheless, certain issues remain: How should 'significant adverse impacts on biodiversity'[57] is justified? What standards should apply to protected areas? Is it necessary to establish core zones, buffer zones or pilot zones? Or should a system of absolute protection term and a relevant protection term be used, in accordance with the area's biological characteristics?[58] How should government authorities and the private sector divide responsibility? In what manner should the government exercise regulation? All these issues require further consideration.

The definition of 'significant adverse impacts on biodiversity' may draw reference from the LOSC. In Part XII, 'Protection and Preservation of the Marine Environment', Article 194(5) notes the importance of biological resources: '[t]he measures taken in accordance with this Part shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life'. This provision may function as the minimum standard of biology resource protection for methane hydrate exploitation operations conducted by a State Party. Thus, protection of 'depleted, threatened or endangered species' should be considered. When viewed together with the CBD, this provision may be understood as offering an interpretation of, 'significant adverse impacts on

57 *Ibid*., Articles 7, 8, 9, 14, 16.

58 L Fengning, 'Implementation and improvement of China's marine protected areas system: Focused on the protection of marine biodiversity' (2013) 3 *Law Science Magazine* 75–84, at p. 76 (in Chinese).

biodiversity'. When any of these three categories of species are harmed, then the loss of biodiversity is considered significant and should be prohibited.

Applicable Domestic Law in China and Other State Practice

Applicable Domestic Law in China

Methane hydrate exploitation involves both environmental and energy issues, which require complementary legal regimes. Full exploitation of the mineral should only occur on the premise of the existence of effective environmental protection.[59]

Laws and Regulations Regarding Environmental Risks

China has enacted several laws and regulations for environmental protection, including the Environmental Protection Law,[60] the Marine Environment Protection Law[61] and the Atmospheric Pollution Prevention and Control Law.[62] These instruments are, to some extent, relevant to methane hydrate exploitation. Nevertheless, given the existing inadequate technology and the unlikelihood of commercial exploitation in the short term, currently there is no specific law on methane hydrate.

The Atmospheric Pollution Prevention and Control Law is China's primary legal instrument devoted to climate change. Articles 8 and 9 provide that the State Council and the provincial people's government are responsible for developing atmospheric environment quality standards and, on the basis of the former, atmospheric pollutant discharge standards. These standards may set the allowable amount of methane emissions from methane hydrate. For methane hydrate projects undertaken by private enterprises, Article 18 requires that

59 Y-C Chang, 'Chinese legislation in the exploration of marine mineral resources and its adoption in the Arctic Ocean' (2019) 168 *Ocean and Coastal Management* 265–273.

60 The Environmental Protection Law of the People's Republic of China was revised on 24 April 2014 at the eighth meeting of the Standing Committee of the Twelfth National People's Congress of the People's Republic of China and came into on 1 January 2015, Presidential Order No. 9.

61 The Marine Environmental Protection Law of the People's Republic of China was revised on 4 November 2017 at the thirtieth meeting of the Standing Committee of the Twelfth National People's Congress, entered into force on 5 November 2017, Presidential Order No. 81.

62 The Atmospheric Pollution Prevention and Control Law of People's Republic of China was amended on 29 August 2015 at the sixteenth meeting of the Standing Committee of the Twelfth National People's Congress of the People's Republic of China, entered into force on 1 January 2016, Presidential Order No. 31.

environmental impact assessments be conducted and atmospheric pollutant discharge standards be abided by.[63] It should be noted that there is no clear definition of 'atmospheric pollutants'. Article 78 stipulates that '[t]he competent department of ecology and environment under the State Council shall, together with the health administrative department under the State Council, publish a directory of toxic and hazardous atmospheric pollutants for risk management in view of the harm and influence of atmospheric pollutants to public health and the ecological environment'. To date, there is no official atmospheric pollutants directory and, as such, it is uncertain whether methane would be categorised as an atmospheric pollutant and, accordingly, whether the Atmospheric Pollution Prevention and Control Law is applicable to methane hydrate exploitation projects.

The Marine Environment Protection Law is applicable to oceanic methane hydrate exploitation. Article 20 enshrines the responsible government principle, stipulating that marine environment protection and regulation is the government's responsibility.[64] In terms of areas available for exploitation, Articles 22 and 23 provide for marine nature reserves and marine special reserves, but does not specify the nature of or conditions for permissible projects in these reserves. It is questionable whether methane hydrate exploitation projects would be permitted in these two special zones.

In terms of procedures for exploitation, methane hydrate projects fall into the category of marine construction projects, which are regulated under Chapter VI of the Marine Environment Protection Law. Specifically, marine construction projects must comply with the national major marine functional zoning plans, the marine functional zoning scheme, marine environment protection plans, and relevant standards of the State on environment protection. Before initiating a marine construction project, the entity undertaking the

63 Atmospheric Pollution Prevention and Control Law, Article 18: 'When building projects that have an impact on [the] atmospheric environment, enterprises, public institutions, and other business entities shall conduct environmental impact assessments and publish the environmental impact assessment documents according to the law; when discharging pollutants to the atmosphere, they shall conform to the atmospheric pollutant discharge standards and abide by the total quantity control requirements for the discharge of key atmospheric pollutants'.

64 Marine Environment Protection Law, Article 20: 'The State Council and the coastal local people's governments shall adopt effective measures to protect typical and representative marine ecosystems such as mangroves, coral reefs, coastal wetlands, islands, bays, estuaries and important fishery waters, protect sea areas where rare and dying out marine organisms are naturally and densely scattered, protect habitats of marine organisms having important economic value, and protect marine natural historic relics and natural landscapes having great scientific and cultural significance'.

project must 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. Chapter VI also contains provisions on the prevention and control of oil spill incidents, pollutant discharges, and oil spill contingency plans for offshore petroleum exploration and exploitation activities. Such provisions, although not directly applicable, may be taken as a reference for future legislation concerning methane hydrate.

In terms of environmental damage, Article 2(3) makes it clear that this law 'shall also apply to pollution to the sea areas under the jurisdiction of the People's Republic of China originating from areas beyond the sea areas under the jurisdiction of the People's Republic of China'. This provision could be used to address transboundary environmental damage claims. Remedies under this law are centred on the marine ecological protection compensation system.[65] Shandong province has also developed local regulations, entitled Measures on the Administration of Marine Ecological Compensation,[66] which provide more detailed guidance at the provincial level. This law takes a strict liability approach to pollution caused by exploitation projects,[67] and the party

65 *Ibid*., Article 24: 'The state shall establish and improve the marine ecological protection compensation system'.

66 Notice of Shandong Provincial Department of Finance, Shandong Marine and Fishery Department, Measures on the Administration of Marine Ecological Compensation, [2016] No. 7 (in Chinese).

67 Marine Environment Protection Law (n 64), Article 73: 'In the case of any of the following acts in violation of the provisions of this Law, the department empowered by this Law to conduct marine environment supervision and control shall order the violator to stop the illegal act and take corrective action within a prescribed time limit or order the violator to take such measures as restricting production or suspending production for rectification, and impose a fine thereon. Where the violator refuses to take corrective action, the department that makes the punishment decision in accordance with the law may impose continuous fines thereon in the amount of the original fine for each day from the next day after the violator is ordered to take corrective action. If the circumstances are serious, the violator shall be ordered to stop operations or be closed down with the approval of the competent people's government: (1) Discharging into any sea area any pollutants or any other substances the discharge of which is prohibited by this Law; (2) Failing to discharge pollutants into the sea in accordance with the provisions of this Law, or discharging pollutants in excess of standards or total discharge volume control indicators; (3) Dumping wastes into the sea without obtaining a permit for dumping wastes into the sea; (4) Failing to take immediate measures to handle any marine environmental pollution accident resulting from any accident or any other emergency. For any violation as mentioned in (1) and (3) of the preceding paragraph, a fine of not less than RMB 30,000 yuan but not more than 200,000 yuan shall be imposed; for any violation as mentioned in (2) and (4) of the preceding paragraph, a fine not less than 20,000 yuan but not more than 100,000 yuan shall be imposed'.

responsible for a marine environment pollution incident is required to repair the damage and compensate those who suffered damage. Article 91 provides for the possibility of liability exemption:

> where damage to the marine environment caused by a pollution cannot be avoided despite prompt and reasonable adoption of measures, and where the pollution is entirely attributable to any of the following circumstances, the parties concerned held responsible shall be exempt from liability: (1) war; (2) irresistible natural calamities.

In the context of methane hydrate exploitation, however, ambiguity may arise: if a methane hydrate exploitation project caused a massive methane leak, which led to continental shelf subsidence or collapse and subsequent underwater mudslides, would the 'irresistible natural calamities' exemption apply? If such events are not sudden but cumulative, a causal relationship to damage would be more difficult to determine.

The Environmental Protection Law is applicable to continental methane hydrate exploitation. On basis of the authorisation of Article 53, the then Ministry of Environmental Protection (currently the Ministry of Ecology and Environment) issued the Measures for Public Participation in Environmental Protection, which creates a framework for public oversight of mineral exploitation projects. The administrative departments of environmental protection are required to solicit the opinions of citizens, interested parties and other organisations on relevant environmental protection matters or activities through questionnaire surveys, holding of symposia, expert demonstration meetings, or hearings by any other means. In 2017, specifically for offshore projects, the State Oceanic Administration issued a new policy document on public participation.[68] This new policy removed the public participation section from marine environmental impact assessment reports, but requires the entity undertaking the project to formulate a statement on public participation in project environmental impact assessment regarding the marine construction, together with an undertaking on the objectiveness and authenticity of the public participation statement. The entity undertaking the marine construction project is required to ensure public participation at three different stages: at the beginning of environmental impact assessment, during the composition of the environmental impact assessment report and before the report's submission for approval. These reforms emphasise the entity's responsibility to

68 Notice of the State Oceanic Administration on Several Issues relevant to Public Participation in Marine Construction Projects Environmental Impact Assessment Reports (Guo Hai Huan Zi No. [2017] 4) (in Chinese).

ensure public participation throughout the environmental impact assessment process, set out detailed guidance for public participation, and encourage the relevant governmental authority's supervision of the process. If the reforms to improve public participation prove to be effective, they may be introduced to the regulatory process for other types of construction projects.

Laws and Regulations Regarding Energy

As methane hydrate has been categorised as a mineral, it most closely falls under the Mineral Resources Law.[69] Ownership of mineral resources is vested in the State. An exploiter may, thus, only exercise rights other than title to mineral resources, and prospecting and exploitation activities may only be undertaken upon approval by the State. As a result, mineral resources administration should extend to methane hydrate exploitation. Prospecting and exploitation permits can only be obtained from the Ministry of Natural Resources upon examination and approval; the Ministry will set out prospecting regions and ensure that rights registration is properly carried out.[70] The 2017 Plan for the Reform of the Mineral Resource Royalty System requires payment of a certain amount of proceeds (mineral resource tax) by the assignee of rights (the contractor) to the owner (the State). The 2017 Plan is intended to protect and realise the State's rights and interests in the mineral resource and to create a fair competition in the mining market. If methane hydrate enters into a commercial utilisation phase, the assignee of rights would have to abide by this framework and pay the required mineral resource tax.

Laws and Regulations Regarding Geological Hazards

The Emergency Response Law[71] adopts principles of 'uniform leadership, comprehensive coordination, categorised management, graded responsibility, and territorial management' in response to natural hazards management.[72]

69 The Mineral Resources Law was adopted at the fifteenth meeting of the Standing Committee of the Sixth National People's Congress on 19 March 1986, entered into force 1 October 1986, Presidential Order No. 36.

70 China Geological Survey, 'What considerations does the project undertaker have in industrialisation? What are the Ministry of Land and Resources' plans for further action?' available at http://www.cgs.gov.cn/ddztt/jqthd/trqshw/wenzi/201706/t20170602_431337.html; accessed 20 January 2020 (in Chinese).

71 The Emergency Response Law was adopted at the twenty-ninth meeting of the Standing Committee of the Tenth National People's Congress of the People's Republic of China on 30 August 2007, entered into force on 1 November 2007, Presidential Order No. 69.

72 Natural hazards referred to are earthquakes, tsunamis, typhoons, and floods. During the exploration for methane hydrate, an earthquake might be triggered and cause geological hazards.

The 2011 *Decision of the State Council on Strengthening the Prevention and Control of Geologic Hazards* reiterates this principle, providing that

> stick[ing] to territorial management and graded responsibility clarifies the local government's role as the primary responsibility holder for geologic hazards prevention and control. Geological hazard risk assessment is the primary preventive measure. Construction projects in vulnerable areas must carry out geological hazard risk assessments, in strict compliance with the relevant requirements. Careful measures must be taken, to prevent geological [incidents] being triggered by human activities. Biological protection and supervision during resource exploitation should be strengthened and biological environment monitoring and assessment undertaken in vulnerable areas.[73]

Projects must avoid high risk areas, suggesting that under the current policy, methane hydrate exploitation in geologically vulnerable areas is strictly prohibited.

Chapters IV and V of the Regulation on the Prevention and Control of Geological Disasters[74] respectively provides for prevention of and emergency response to geological disasters. Projects in a geologically vulnerable area must conduct geological hazard risk assessments during the feasibility phase. Should any risks be identified, the project proponent should propose specific prevention and control measures and will be responsible for evaluation of the results. The project proponent is also obligated to carry out the accompanying geological hazards preventive and control measures. If the project does cause a geological hazard, then the responsible project operator must assume strict liability for the tortious activity and carry out hazard control activities or pay for hazard control costs. Articles 4 and 5 of the National Geologic Hazard Contingency Plan provide for alert and response systems for geological hazards of various grades. In 2015, the State Oceanic Administration issued the Emergency Response Plan for Storm-Tide, Sea Wave, Tsunami and Sea Ice Disasters. Article 4 of the Response Plan details the division of responsibilities and coordination of efforts among government branches, forecast centres,

73 State Council, *Decision of the State Council on Strengthening the Prevention and Control of Geologic Hazards*, Order No. [2011] 20.

74 The 29th executive meeting of the State Council approved the Regulation on the Prevention and Control of Geological Disasters, State Council Decree No. 394 promulgated on 24 November 2003, entered into force 1 March 2004.

hazard mitigation centres and monitoring centres in responding to marine hazards of various grades.

These laws and regulations on geological hazards show that, as a general rule, China attaches great importance to the prevention and control of geological hazards, with hazard control taking priority over mineral resource exploitation. At the operational level, the relevant departments are coordinated in the management system, which will facilitate implementation.

Laws and Regulations Regarding Biodiversity Conservation

The Marine Environment Protection Law provides that where an area has significant marine biodiversity, a marine nature reserve or marine special reserve should be established. Article 13 of the Measures on the Administration of Marine Nature Reserves[75] stipulates that, on the basis of the natural environment, natural resources condition and necessity for conservation, marine nature reserves may be 'divided into three parts: the core zone, buffer zone and experimental zone'. In the core zone, any activity that may threaten or adversely affect the reserve is prohibited, except for surveying, observation and scientific research activities approved by the ocean administration of the relevant coastal provinces, autonomous regions or municipalities. A similar scheme is applied in the Regulations on Nature Reserves.[76] As such, for methane hydrate located in a core zone, it is uncertain whether exploratory prospecting and research activities fall within the scope of 'scientific research activities' and thereby would allow for the collection of samples from a core zone. This author holds the view that, where sample collection is possible in a non-core zone, the same activity in a core zone should be prohibited. Where research activities in a core zone are deemed necessary, such activities should be accompanied by a robust environmental impact assessment so as to balance biodiversity conservation and resource exploitation.

75 Promulgated by the State Oceanic Administration on 29 May 1995, entered into force 29 May 1995.

76 Decree No. 167 of the State Council of the People's Republic of China on 9 October 1994. On 7 October 2017, Premier Li Keqiang of the State Council signed the State Council Decree No. 687 of the People's Republic of China, amending the Regulations on Nature Reserves of the People's Republic of China. See Article 18, paras 1, 2: 'Nature reserves may be divided into three parts: the core zone, buffer zone and experimental zone. The intact natural ecological systems and the areas where precious rare and vanishing wildlife species are concentrated within nature reserves shall be delimited as the core zone into which no units or individuals are allowed to enter. No scientific research activities are allowed in this zone except for those approved according to Article 27 of these Regulations'.

Other State Practice

The United States

The United States has enacted the Methane Hydrate Research and Development Act[77] (see further below). In addition, seven other laws are applicable to methane hydrate: the Mining and Minerals Policy Act,[78] the Outer Continental Shelf Lands Act,[79] the Coastal Zone Management Act,[80] the Clean Water Act,[81] the National Environmental Policy Act,[82] the Marine Mammal Protection Act[83] and the Endangered Species Act.[84] Laws and regulations on clean air, fisheries, historic preservation, and oil and gas royalty management may also be relevant to methane hydrate development.[85]

The Methane Hydrate Research and Development Act of 2000, as amended in 2005, authorises the Secretary of Energy to award grants or contracts to industrial enterprises or educational institutions for the purpose of further exploring methane hydrate, as well as developing safe and environmentally-friendly technologies to exploit methane hydrate resources. Section 4 of the Act also amended the Mining and Minerals Policy Act by adding methane hydrate to the list of 'mineral resources' to be regulated under the latter. The Act calls for cooperation among the government, industrial enterprises and educational institutions on eco-friendly development of methane hydrate. For this purpose, the Methane Hydrate Advisory Committee was established.

In terms of biodiversity protection, the Marine Mammal Protection Act and the Endangered Species Act are applicable. Firstly, as to the degree of protection, the Marine Mammal Protection Act makes it illegal for any individual to 'take' a marine mammal within the United State.[86] 'Take' is defined broadly to include harassment, hunting, killing, capturing or attempting to perform any of these activities.[87] The Endangered Species Act provides stronger protection for listed species by expanding the definition of 'take' to include harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing or collecting or attempting to perform any of these activities.[88] Oceanic methane

77 Methane Hydrate Research and Development Act of 2000, 30 USC §1902 (2000).
78 Mining and Minerals Policy Act of 1970, 30 USC § 21a (1970).
79 Outer Continental Shelf Lands Act of 1953, 43 USC § 1301 (1953).
80 Coastal Zone Management Act of 1972, 16 USC § 1451 (1972).
81 Clean Water Act of 1977, 33 USC §1251 (1977).
82 National Environmental Policy Act of 1969, 42 USC § 4321 (1969).
83 Marine Mammal Protection Act of 1972, 16 USC § 1361 (1972).
84 Endangered Species Act of 1973, 16 USC § 1531 (1973).
85 E Jackson, 'Fire and ice: Regulating methane hydrate as a potential new energy source' (2014) 29 *Journal of Environmental Law and Litigation* 616–629, at p. 611.
86 16 USC § 1372(a)(2)(A) (2012).
87 16 USC §1362(13).
88 16 USC § 1532(19).

hydrate exploitation may result in habitat modification, which is harmful for marine life. Project proponents should, thus, comply with the relevant laws and regulations to try to prevent such harm. In terms of method of protection, the Endangered Species Act not only makes it unlawful for individuals to take a listed species, but also requires federal agencies to ensure any federal action does not result in placing any listed species in jeopardy.[89] As a consequence, when reviewing methane hydrate projects, if a federal agency determines that the project is likely to jeopardise the continued existence of an endangered species, the agency will, on the basis of an in-depth investigation, suggest reasonable and prudent alternatives to the applicant (project proponent).[90] The goal of habitat preservation is thereby achieved.

The technologies to produce natural gas from methane hydrate are similar to those used in the conventional oil and gas industry, thus, the pollutants produced are similar and include aluminium, arsenic, barium, benzene, cadmium and chromium.[91] As required by the Clean Water Act, any discharge of a pollutant is prohibited unless a permit is obtained.[92] Further, the Clean Water Act adopts a strict liability approach; under Section 311, an owner or operator in charge of a vessel or an onshore facility that has discharged oil or hazardous substances will be liable to the United States government for the actual costs of removal of such oil or substance, unless he/she can prove that a discharge was caused solely by *force majeure*, an act of war, negligence on the part of the United States government or an act or omission of a third party.[93] Should pollutants be discharged from a methane hydrate project, the project proponents will be liable for undertaking the clean-up or the costs of such action taken on its behalf.

The Russian Federation

Russia exploited its first methane hydrate deposit in 1965, proving that methane hydrate is a viable energy resource. In 1969, the Messoyakha methane hydrate deposit was brought into commercial production.[94] In addition to methane hydrate discovered domestically, Russia also has significant offshore Arctic methane hydrate deposits. The United Nations Commission on the Limits of

89 Jackson (n 85), at p. 627.

90 16 USC §1536(b)(3)(A), § 1536(c)(1).

91 Jackson (n 85), at p. 624.

92 33 USC § 1342(a)(1).

93 L Zhongmei, *Ideal and Reality: China's Environmental Disputes and Remediation Regimes* (Law Press China, 2011), at p. 170 (in Chinese).

94 Y Mingqing, Z Guiyi and W Qian, 'The development status and prospect of combustible ice in Russia' (2018) 2 *Oil Drilling and Production Technology* 198–204, at p. 200 (in Chinese).

the Continental Shelf is reviewing the Russian Federation's submission on the outer limit of the Arctic continental shelf in accordance with the LOSC. Russia is likely to acquire a continental shelf area of 120×104 km^2.[95] Should that be the case, Russia's methane hydrate reserves would increase to 3180×1012 m^3.[96] In 2014, the Joint Institute for High Temperatures of the Russian Academy of Science drafted the Energy Industry Innovative Development Plan. Under the Plan, methane hydrate development is expected to reach a new level of development by 2030, becoming a necessary supplement to natural gas production, and thus consolidating Russia's position in the international natural gas market.

Japan

Geological surveys show that under the Nankai Trough off Japan's south-central coast there are pore-filling methane hydrate-bearing layers. The layers are of such width and depth that the methane hydrate reserve size is estimated to be 1.1414 trillion m^3, of which 0.574 trillion m^3 are recoverable, which is sufficient to replace eleven years of natural gas imports.[97] Given its small land area, energy shortages and the enforced shutting down of nuclear power plants after earthquakes,[98] development of methane hydrate reserves, a relatively abundant natural resource, has been the focus of the Japanese government. Since 2001, the Japanese government has invested 115.4 billion yen in methane hydrate commercialisation research.[99] Nevertheless, technological problems have hindered the pilot methane hydrate exploitation project, which was forced to temporarily shut down twice, in 2013 and 2017, due to sandstone influx. Additionally, methane hydrate is expensive to produce, while traditional oil and gas prices have been lower and more stable. With the rise of other alternative energy sources across the globe, it is uncertain whether methane hydrate commercialisation is economically viable. Against such a background, the Japanese government might have to give up its independent development projects. It is reported that Japan will work with the United States to extract

95 *Ibid.*
96 *Ibid.*
97 W Xiansi, 'The evolution course of Japan's combustible ice development technology' (2016) S1 *China Petroleum and Chemical Industry* 183, at p. 183 (in Chinese).
98 Chang and Zhao (n 48).
99 Cankaoxiaoxi, 'Japanese media: Japan may give up independent methane hydrate development, and cooperate with the US or India instead' available at http://news.163.com/17/0629/12/CO3KJD5Q00018AOQ.html; accessed 20 August 2018 (in Chinese).

methane hydrate in Alaska, as well as cooperate with India on a pilot oceanic methane hydrate extraction project.[100]

The European Union

The European Union (EU) has a deliberate and cautious mechanism for methane hydrate exploitation risk management. Firstly, with the polluter pays principle set out under the Treaty on the Functioning of the EU,[101] methane hydrate-related incidents are governed by a rule of strict liability. Secondly, several directives are applicable to environmental protection and associated torts, with the most relevant being the Environmental Impact Assessment (EIA) Directive[102] and the Strategic Environmental Assessment Directive.[103] Other directives, such as the Offshore Directive,[104] the Directive on the Geological Storage of Carbon Dioxide[105] and the Marine Strategy Framework Directive,[106] are also applicable.[107]

The public participation system provided for under the EIA Directive is comprehensive and provides the most valuable reference for assessment of methane hydrate projects. Firstly, at a minimum, the project proponent

100 *Ibid.*

101 The Treaty on the Functioning of the European Union entered into force in 2009 (OJ C 115/47, 9 May 2008), following amendments introduced by the Treaty of Lisbon (OJ C 306/1, 17 December 2007).

102 European Union, Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment Text with EEA relevance, OJ L 124/1, 25 April 2014 [EIA Directive].

103 European Union, Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment, OJ L 1997/30, 21 July 2001 [SEA Directive]. The EU ratified the Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact Assessment in a Transboundary Context (Kiev, 21 May 2003, in force 11 July 2010, 2685 *UNTS* 140) on 21 November 2008. The provisions of the Protocol are incorporated into the SEA Directive.

104 European Union, 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 (text with EEA relevance), OJ L 178/66, 28 June 2013.

105 European Union, Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide (text with EEA relevance) (2009/31/EC), OJ L 140/114, 5 June 2009.

106 European Union, 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 (text with EEA relevance), OJ L 164/19, 25 June 2008.

107 RA Partain, 'A comparative legal approach for the risks of offshore methane hydrate: Existing laws and conventions' (2015) 32 *Pace Environmental Law Review* 791–927, at p. 851.

must submit the following information: (a) the size and design of the project; (b) the main effects which the project is likely to have on the environment; (c) the measures envisaged, in order to avoid, reduce and if possible, remedy significant adverse effects; (d) any alternatives, on basis of potential environmental effects; and (e) a non-technical summary. In addition, these five elements should address both their direct and indirect effects on (i) human beings, fauna and flora, (ii) soil, water, air, climate and the landscape, (iii) material assets and cultural heritage, and (iv) the interaction between two or more of these factors.[108]

Secondly, the description of the project needs to explain the production processes of the methane hydrate project and provide estimates of the expected residues and emissions for all forms of pollution.[109] For the various impacts and potential harm and hazards listed in the description, potential means of prevention, reduction and offsetting measures should be provided in the assessment. A report of the scientific methods and techniques involved, together with a non-technical version of the assessment, is also required.[110]

Thirdly, with regard to non-developer parties' participation, the Member States are required to ensure that all relevant authorities are given an opportunity to express their views on the assessment and that all information regarding the project is disclosed to the general public. The general public has a right to either receive a 'sufficient interest notice' of the review and development of the assessment or to have access to due process before a court of law or other independent and impartial body to challenge the decisions, acts or omissions on substantive or procedural grounds.[111]

The EIA Directive has greatly enhanced public participation in and transparency of methane hydrate projects. The general public and the relevant authorities both play a supervisory role, thereby encouraging the project proponent to take due care in resource exploitation. In addition, the requirement for both technical and non-technical versions of assessment reports facilitates the public's understanding of the project, which will in turn promote public participation. As a result, this should lower environmental risks from the outset and mandate the project proponent to establish appropriate environmental protection rules and procedures at the preparatory stage.

108 *Ibid.*, at p. 861.
109 EIA Directive (n 102), Article 6.
110 *Ibid.*, Annex IV.
111 *Ibid.*, Article 9.

Reflections and Suggestions for China

Improve the Environmental Impact Assessment System for Methane Hydrate Projects

As a major preventive step for risk control, an improved environmental impact assessment system is necessary for methane hydrate projects in China. Applicable laws and regulations in this respect include the Law on Environmental Impact Assessment,[112] the Regulations on the Administration of Construction Project Environmental Protection,[113] and the Administrative Regulations on the Prevention and Treatment of the Pollution and Damage to the Marine Environment by Marine Engineering.[114]

In terms of the environmental impact assessment framework, Article 3 of the Law on Environmental Impact Assessment stipulates that '[t]o work out any of the programmes as described in Article 9 of the present Law or to build any project within the territory of the People's Republic of China or within other seas subject to the jurisdiction of the People's Republic of China, appraisals shall be conducted about the environmental impacts according to the present Law'. The phrase 'other seas subject to the jurisdiction of the People's Republic of China' was defined in Article 1 of the 2016 *Provisions of the Supreme People's Court on Several Issues concerning the Trial of the Relevant Cases Occurring in Sea Areas under the Jurisdiction of China* (*I*) as 'sea areas under the jurisdiction of China'.[115] This phrase is to be read in conjunction with 'inland waters, territorial seas, contiguous zones, exclusive economic zones, and continental shelves' and should be interpreted as relating to the Diaoyu Island (Senkaku Islands), the Xisha Islands (Paracel Islands) and Nansha Islands

112 The Law on Environmental Impact Assessment was adopted at the thirtieth meeting of the Standing Committee of the Ninth National People's Congress on 28 October 2002, entered into force 1 September 2003. The Second Amendment was adopted at the seventh meeting of the Standing Committee of the Thirteenth National People's Congress on 29 December 2018, Presidential Order No. 24.

113 Decree No. 253 of the State Council of the People's Republic of China, 29 November 1998.

114 Decree No. 475 of the State Council of the People's Republic of China, an instrument approved by the 148th Executive Meeting of the State Council on 30 August 2006, announced on 9 September 2006, entered into force on 1 November 2006.

115 *Provisions of the Supreme People's Court on Several Issues concerning the Trial of the Relevant Cases Occurring in Sea Areas under the Jurisdiction of China* (*I*), adopted in the 1674th meeting of the Judicial Committee of the Supreme People's Court on 28 December 2015 and effective as of 2 August 2016, Fa Shi [2016] No.16, Article 1: 'For purposes of these Provisions, the term "sea areas under the jurisdiction of China" means China's inland waters, territorial waters, contiguous zones, exclusive economic zones, continental shelves as well as other sea areas under the jurisdiction of the People's Republic of China'.

(Spratly Islands), as well as other sea areas subject to sovereignty disputes. This suggests that the environmental impact assessment framework has a broad territorial scope. When conducting methane hydrate exploitation activities in disputed sea areas, the project proponent must carry out an environmental impact assessment, in accordance with Chinese laws and as such, in conformity with China's sovereignty and national interests.

In terms of public participation, the environmental impact assessment report under the Regulations on the Administration of Construction Project Environmental Protection is modest in scope, in comparison to the EU EIA Directive. For example, in the Chinese regulations there is no requirement for any alternative proposal or a distinction between technical and non-technical reports. The formulation of a non-technical report is vital for public participation. An environmental impact assessment report, which is technical in nature, would be incomprehensible to most of the general public.[116] Any hindrance to public participation would undermine the purpose of the entire system.

In addition, Article 16 of the Law on Environmental Impact Assessment requires that 'the State practices classified management over the appraisals of the environmental impacts of construction projects according to the seriousness of the impacts'. The Classified Administration Catalogue of Environmental Impact Assessments for Construction Projects, as revised by the Ministry of Ecology and Environment in 2018, lists newly developed oil, natural gas or shale gas projects all as being projects that may have a major impact on the environment. By analogy, methane hydrate exploitation activities could also be characterised as 'projects that may cause major impact on the environment'. Thus, the project proponent has a higher level of duty of care and is obliged to take appropriate precautionary measures to prevent environmental damage.

China may draw references from the EU EIA Directive and enact more detailed provisions on public participation. For example, project proponents could be required to provide a technical report for the professionals, as well as a plain language version for the general public. Such a distinction would increase public participation in environmental impact assessment and be more effective in inhibiting or preventing environmental risks.

Establish an Environmental Liability Insurance System

Activities that negatively impact the environment may cause, on the one hand, environmental torts, that is, injury to a civil law party's personal or property rights with the environment as the medium, and on the other, injury to the

116 W Jin, *The Chinese Approach to Environmental Rule of Law: Reflections and Explorations* (China Environmental Science Press, 2011), at p. 230 (in Chinese).

environment *per se*, that is, deterioration of the environment and harm to the public's right to a good environment. These two forms of injury may both be present.[117] As discussed above, methane hydrate exploitation projects may cause damage to personal or property rights. Exploitation of oceanic methane hydrate may cause underwater mudslides, even tsunamis, which in turn, may result in casualties. For continental methane hydrate projects, methane leakage may pollute the air and cause physical discomfort to nearby residents. Such potential physical and property injuries to third parties fall into the purview of tort law, under which the polluter assumes strict liability and must compensate the victim for his or her losses. For the second type of injury, to the environment *per se*, tort law is not applicable. Leaked methane may pollute the atmosphere, aggravate the greenhouse effect or even result in the destruction of marine species or trigger underwater geologic hazards. The environment interests of humankind are thereby likely to be harmed, although few could claim direct harm. This means that it is very difficult to proceed to allocate liability and determine compensation.

In such cases, compensation to victims may be perceived as being not as important as pollution control and environment restoration. The cost of restoration may be very high, hence the need for an environmental liability insurance system. In the United States, pollution legal liability covers not only third-party bodily injury and property damage claims, being comparable to traditional environmental liability insurance, but also costs related to pollution control, clean-up and remediation.[118] Article 52 of the Environmental Protection Law in China provides that the State must encourage the project proponent to purchase environmental pollution liability insurance as an extension of more general public liability insurance. Article 26 of the Administrative Regulations on the Prevention and Treatment of the Pollution and Damage to the Marine Environment by Marine Engineering provides that a marine oil and gas mineral resources exploration and exploitation entity must purchase the relevant pollution and damage liability insurance. When considering applicable administrative regulations, only the Measures for the Implementation of Civil Liability Insurance for Vessel-induced Oil Pollution Damages establish a requirement for environmental liability insurance for oil pollution by vessels; there is no compulsory regime for pollution associated with mineral resources

117 S Yucheng, 'A structured reflection on environmental interest, environmental rights and environmental power: From a legal interest analysis perspective' (2013) 5 *Studies in Law and Business* 47–57, at p. 54 (in Chinese).

118 DL Guevara and FJ Deveau, *Environmental Liability and Insurance Recovery* (American Bar Association Publishing, Washington, D.C., 2012), at pp. 516–518.

exploitation. In 2017, the then Ministry of Environmental Protection promulgated the Measures on the Administration of Compulsory Environmental Pollution Liability Insurance (Draft for Comment). The Draft Measures were intended to apply to 'enterprises of high environmental risk', including those in the oil and natural gas industry. Given that methane hydrate is still at the prospecting phase, with very limited production output, compulsory environmental pollution liability insurance is likely to be inapplicable or at least not a priority. Nevertheless, given the large reserves, its high-energy capacity and the rapid progress on research, methane hydrate may become an alternative to oil and natural gas. Should this be the case, the scope of legislation must be expanded accordingly to cover methane hydrate. Insurance provisions under the Draft Measures also covered third party personal injury and property damage, environmental damage and costs of emergency response and clean-up. Such provisions could provide sufficient compensation for victims while maximising the protective/preventative effect for the environment. China should, therefore, establish an environmental liability insurance system. In the event on an incident, the polluter could combine the financial resources of the insurer and its knowledge of the pollution incident so as to efficiently realise a clean-up operation.[119]

Incorporate the 'Golden Rules' into Chinese Domestic Law

To minimise or prevent environmental risks, a methane hydrate exploitation project should adopt strict procedural safeguards, including site selection and preparatory work prior to exploration, monitoring and management during project operations, and incident resolution and remediation. It is, therefore, suggested that a set of rules be established for exploitation activities so as to coordinate resource utilisation and environmental protection. Some commentators contend that methane hydrate is essentially irregular natural gas,[120] in which case, the 'Golden Rules' as proposed by the International Energy Agency for natural gas may be applicable.[121]

It is suggested that the Golden Rules could help realise economic and energy security benefits while meeting public concerns. The Rules also have implications for governments and industry, including development costs, as well as

119 M Ning, 'Legal framework for environmental liability insurance and environmental risk control' (2018) 1 *Chinese Journal of Law* 106–125, at p. 109 (in Chinese).

120 China Petroleum News Centre, 'Inflammable ice: Bellwether for unconventional natural gas' available at http://news.cnpc.com.cn/system/2017/12/28/001673586.shtml; accessed 20 January 2020 (in Chinese).

121 International Energy Agency (IEA), *Golden Rules for a Golden Age of Gas* (Paris, IEA, 2013).

global energy trade patterns and pricing, energy security and climate change.[122] Further, the Golden Rules set out 'principles that can allow policy-makers, regulators, operators and others to address … environmental and social impacts [of unconventional gas production sources] in order to earn or retain [public] consent'.[123] Since their application could bring a higher level of environmental protection performance and public acceptance, that could maintain or earn the industry a 'social license to operate' within a given jurisdiction, paving the way for the widespread development of unconventional gas resources on a large scale, boosting overall gas supply and making the golden age of gas a reality.[124] The Golden Rules are focused on seven aspects of production: measurement, disclosure and engagement; watch where you drill; isolate wells and prevent leaks; treat water responsibly; eliminate venting, minimise flaring and other emissions; be ready to think big; and ensure a consistently high level of environmental performance.[125] The Rules emphasise transparency, measuring and monitoring environmental impacts, and engagement with local communities during natural gas exploration and exploitation.

Such aspects are somehow overlooked in China's mineral resources exploration and exploitation practices. Although the Environmental Protection Law and the Mineral Resources Law are in place, there is no unified regulatory authority and the regulatory instruments on transparency and public participation do not rank highly. For example, the Notice of the State Oceanic Administration on Several Issues Relevant to Public Participation in Marine Construction Projects Environmental Impact Assessment Reports is merely a departmental regulatory document, which contains rather loose standards. The degree and method of public participation are left to the discretion of the project proponent. As a result, in China, mineral resource exploitation and environmental protection are treated as two separate issues. The core values contained in the Golden Rules should be integrated into China's regimes on public participation, environmental impact assessment and information disclosure so as to build a set of systematic and viable rules for methane hydrate exploration and exploitation.

It is acknowledged that implementing the Golden Rules has the disadvantage of increasing exploitation costs and thereby discouraging investment. Nevertheless, given the potential social and environmental impacts of

122 *Ibid*., at covering page.
123 *Ibid*., at p. 42.
124 *Ibid*., at p. 10.
125 C Shanshan and L Shen Aoyi, 'IEA: Golden rules for a golden age of gas' (2012) 6 *International Petroleum Economics* 6–13, at pp. 8–10 (in Chinese).

methane hydrate exploration and exploitation, the absence of a set of viable rules on the respective rights and obligations of legislators, regulators and project proponents is counterproductive.

Cooperate on Methane Hydrate Development

China's methane hydrate research had been going on for about twenty years before the trial production in the Shenhu area of the South China Sea was declared successful in 2017. Other States, including the United States, Japan, the Russian Federation and Canada, also are only at the preliminary prospecting and trial production stage. This suggests that methane hydrate is not yet suitable for widespread commercial use due to the difficulties faced during exploration and exploitation, inadequate technology and high commercialisation costs. Nevertheless, industrialised methane hydrate use is potentially of great importance for energy security and energy structure optimisation. As such, cooperation with Russia under the Belt and Road Initiative framework is a commendable approach to expediting methane hydrate commercial development as both States consider methane hydrate a possible solution to domestic energy shortages. Historically, Russia, a major energy exporter, and China, a large energy importer, have cooperated with regards to oil and natural gas.[126] Working towards a common objective, the two States could cooperate in methane hydrate exploration technology in areas such as exploitation approaches and environmental risk prevention.

China may, on the one hand, work with Russia to advance methane hydrate development technology, while on the other, cooperate with States surrounding the South China Sea to mitigate territorial disputes in the region. The South China Sea, over which the surrounding States have prolonged territorial disputes, is rich in oil, gas and methane hydrate reserves; thus, methane hydrate development in this region is problematical. In the 1980s, China proposed to set aside disputes and pursue a joint development policy for South China Sea issues in the hope of achieving open cooperation with and mutual benefit for the surrounding States. In recent years, however, certain States in the region have been perceived to be uncooperative and have been conducting separate exploration and exploitation activities, thereby undermining the 'joint development' principle. Some of the parties have been considered as adopting arbitrary and inappropriate interpretations of the joint development principle.[127]

126 Mingqing, Guiyi and Qian (n 94), at p. 202 (in Chinese).

127 C Yixi and C Yen-chiang, 'Legal difficulties and countermeasures for the development of petroleum and gas resources in disputed areas in South China Sea' (2017) 4 *The Journal of South China Sea Studies* 17–26, at p. 25 (in Chinese).

Against such a tense background, it is suggested that China approach the joint development policy with low sensitivity issues, such as transboundary environmental damage prevention, biodiversity conservation, geological hazard prevention, and promote dialogue and consultation in an attempt to resolve the tensions indirectly and pursue common interests.

Conclusion

Methane hydrate is a mineral resource the development of which may cause environmental hazards, such as intensifying the greenhouse effect, adversely impacting biodiversity, and triggering geological impacts and environmental disputes. The commercial use of methane hydrate faces other hindrances, such as disputes over ownership and high development costs. At the international level, there is no specialised legal regime to regulate methane hydrate development and the associated risks, but rules of international energy law, international environmental law and the law of sea may be applicable. The International Energy Charter confirms States' proprietary rights to methane hydrate, laying the foundation for its cooperative development. The LOSC provides for jurisdiction over oceanic methane hydrate in various maritime zones (the territorial sea, the contiguous zone, the exclusive economic zone, the continental shelf and the Area) and sets out the principle that resource development must be consistent with protection of the marine environment. The Paris Agreement and other international treaties on climate change have focused on global emission reductions, setting the overall emission quotas for signatories. Parties are required to estimate the amount of emissions generated by methane hydrate exploitation in advance of undertaking any development projects and make adjustments in accordance with the proponent State's agreed emission allowance.

In terms of biodiversity conservation, the CBD and the LOSC both require that methane hydrate development should comply with the requirement of protecting 'depleted, threatened or endangered species'. Biomass exploration and assessment should be carried out prior to commencement of a development project so as to minimise any negative impact on biodiversity. In terms of transboundary environmental damage, the first step should be pollution prevention by offshore drilling vessels and equipment. Then, close interaction should be maintained with neighbouring States during implementation of the development project, with attention being paid to possible pollution incidents. In addition, given the potential for the widespread transboundary environmental damage from any methane hydrate incidents and the long

latency period for damage to emerge, making a causal relationship difficult to establish, a case-by-case analysis of any exploration-related incident should be adopted.

China has not enacted a specific law for methane hydrate exploration or exploitation, but existing laws and regulations on energy and environmental protection could provide guidance for the preparatory work, environmental risk prevention and incident response for methane hydrate projects. The United States, Japan, the EU and the Russian Federation have all invested significantly in methane hydrate prospecting and technology research, with the United States being the first State to enact a specialised law in this area, namely, the Methane Hydrate Research and Development Act.

Four points should be raised on China's existing law and foreign legislative practices. The first is the need for China to improve the environmental impact assessment system. As discussed above, methane hydrate has high energy capacity and its development could have significant effects on the environment, which means preventive measures are of great importance. In particular, public participation in the environmental impact assessment process should be improved so as to better serve the people and encourage transparency. Second, China should establish an environmental liability insurance system. In the event of a pollution incident, suitable and effective pollution controls and restoration of the environment are imperative. The cost of restoration may be very high, hence the need for an environmental liability insurance system to assist the potential polluter. Third, the Golden Rules regarding systematic planning for natural gas offer lessons on the need to balance resource exploitation and environmental protection. The fourth point is the need to strengthen work towards cooperative development among States. Methane hydrate development projects are extremely demanding and require sophisticated technology and well-informed skilled personnel. Strengthened cooperation, especially with Russia and other developed countries, could expedite technological advancements. Likewise, cooperation with States surrounding the South China Sea might help to mitigate tension and facilitate meaningful and mutually beneficial results.

Methane hydrate development and their future commercialisation are of vital importance to a State's energy security, energy structure optimisation and economic development. China, therefore, should take such measures as necessary to reduce or at least mitigate methane hydrate-related risks, so as to achieve coordinated and sustainable development of its energy supply, enhance its economic stability and growth, and ensure a protected and thriving environment.