

# On Breadth and Depth Space for “Ocean Development”

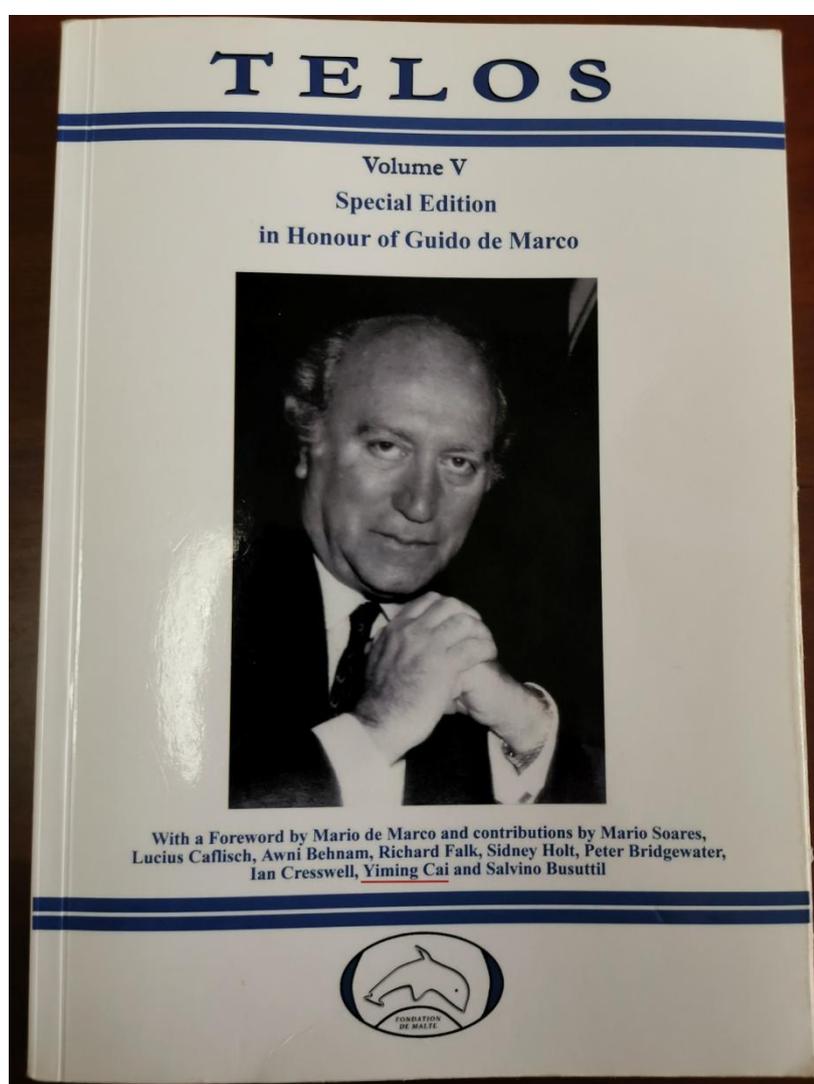
Yiming Cai

“海洋开发”的广度与深度空间论

蔡一鸣

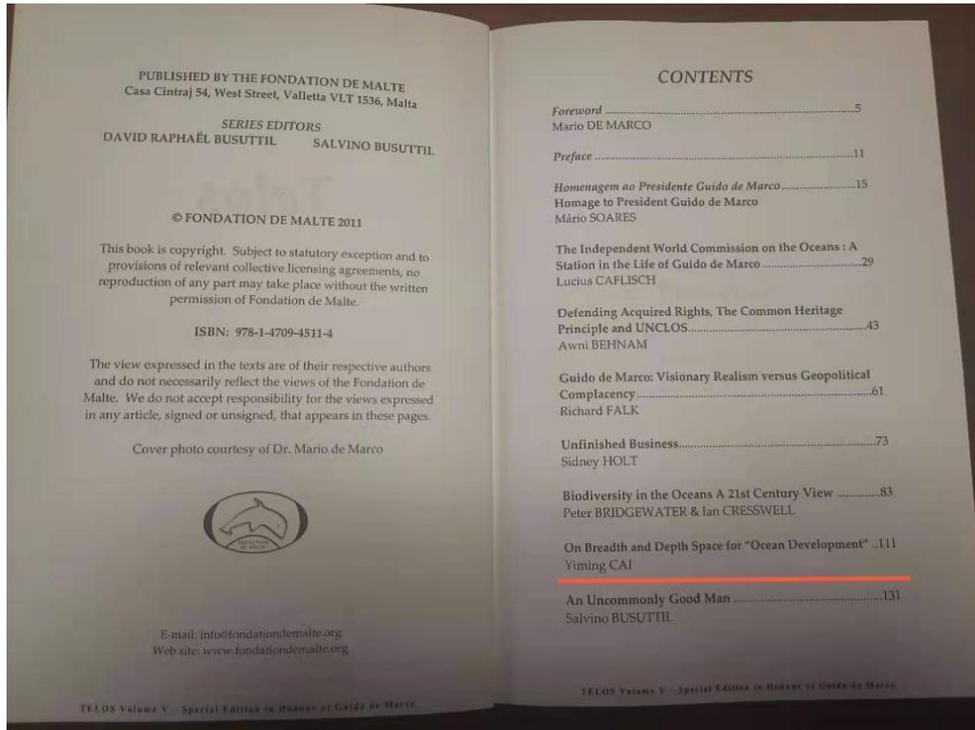
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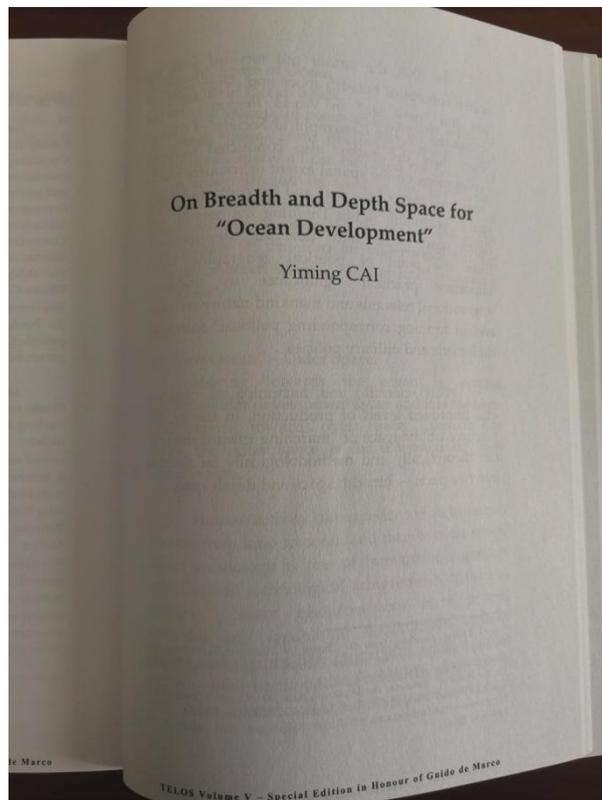
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In 2008, the author put forward with the initial concept of breadth space and depth space of sea and “new sea” in World Regional Studies sponsored by The Geographical Society of China.<sup>1</sup> Since then, the author also conducted in-depth explorations on the spatial extent of resource use in “marching toward the sea” and the control of depth space controlling rights. Dividing the breadth and depth space in sea and “new sea” development, from the point of political geography, holds important practical significance in analyzing international relations and mankind-nature relations and in forming corresponding political, economic, diplomatic and military policies.

With scientific and technological progress and improved levels of production, in theory, the resource utility space of “marching toward the sea” can theoretically and methodologically be divided into two parts — breadth space and depth space.

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<sup>1</sup> CAI Yiming. *Learning from the Theory on Maritime Hegemonies and Building Contemporary Harmonious Oceanography*, in World Regional Studies, Shanghai, 2008. (4)41-48.

*On the Width of Space and the Depth of Space for “Ocean” Development*. BIT’s 1st Annual World Marine Tech Summit-2010, Dalian, China. <http://www.bitconferences.com/mts2010/cn/default.asp> (last accessed 27 February 2011).

## 1. Breadth Space of Ocean

### 1.1 Breadth of Ocean Space.

The breadth of ocean space merely refers to the ocean space. From microscopic space to the entire ocean space, all can be called the breadth of ocean space. Breadth is used in its "horizontal" extension which here simply means the breadth of space between microscopic space and the entire ocean space. It can also be understood that the breadth of ocean space is "planimetric", extending on "a line".

### 1.2 "New Ocean" – Outer Space.

Moving towards the ocean is moving towards wider development space and it is the same with moving towards outer space. Taken in this sense, the outer space is the extension of "new ocean" space.

Human activity has experienced an extension process from land to ocean and then to outer space. Space technology is one of humankind's greatest scientific and technological achievements of the last century. Space resources that have proved utilizable and capable of development include: higher altitude position of aircrafts relative to the surface of the Earth; natural resources of the Moon and other planets; solar energy resources, high

vacuum and microgravity environment resources; strong cosmic ray particles resources and so on.

From land to sea, and then to space, is part of the process whereby human endeavour progresses.

## 2. Depth of Ocean Space

### 2.1 Depth of Ocean Space.

Depth is used in its vertical exploration. On the breadth of the ocean space, the renewable and recyclable energy and other resources that can be continuously explored can be called the depth space of ocean's controlling interests. In other words, developing energy and other resources of the ocean and "new ocean" can be continuously extended in longitudinal direction and points; and depth space can be developed continuously.

#### 2.1.1 Solar Energy

Earth has an ocean area of  $3.6 \times 10^8$  km<sup>2</sup>, accounting for 71% of the total area of the earth. Therefore, the vast boundless ocean on earth's surface has 71% of ocean space receiving "unlimited" solar power from endless depth. Out of the total power of solar radiation, only one in 2.2 billion kW could reach the earth's upper atmosphere. Even such a small part equals to the total power produced by 173 million power stations each with one million kW capacity.<sup>2</sup>

### 2.1.2 Wind Energy

Wind energy resources on the Earth,  $3.8 \times 10^{16} \text{kW} \cdot \text{h}$  of the energy out of the annual radiation energy from outer space are absorbed by the atmosphere which produces about  $4.3 \times 10^{12} \text{kW} \cdot \text{h}$  of wind energy. This figure is roughly 400 times as  $1 \times 10^{10} \text{kW}$ , the power capacity of all the power plants in the world in 1973.<sup>3</sup> Now, the installed large scale sea wind turbines with capacity of over 2-3mW have more advantages than those on the land in costs of installation, transportation and operation, and in wind resource quantity. Offshore wind power reserves in China are three times more than those on land.<sup>4</sup>

### 2.1.3 Thermal Energy

Thermal Energy resources obtained generate reserves with about a  $400 \times 10^8 \text{kW}$  of the world's ocean thermal energy resources.<sup>5</sup> In China they are

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<sup>2</sup> ZUO Ran, MINGSHENG Shi & XILIN Wang. *Introduction to Renewable Energy*. Beijing: China Machine Press, 2007.

<sup>3</sup> LIU Wankun, ZHIYING Zhang, YINFENG Li & PING Zhao. *Wind Power and Wind Power Generation*. Beijing: Chemical Industry Press, 2007:7.

<sup>4</sup> YE Wentian. *CLP, Huadian, CNOOC and other energy giants scrambling for offshore wind power*. Beijing: China Business. [\(2009-04-13\)](http://www.chinapower.com.cn/newsarticle/1089/new1089900.asp)

<sup>5</sup> GUO Yong & CHENGLI San. *Energy and Environment Effects*. Beijing: Chemical Industry Press, p 185-186, 2006.

mainly distributed in the South China Sea and waters east of Taiwan.

#### 2.1.4 Currents Energy

It is estimated that the global energy of currents is as much as  $5 \times 10^9$  kW, the largest kind of ocean energy in terms of reserves.<sup>6</sup>

#### 2.1.5 Wave Energy

According to the estimate of the World Energy Agency (IEA), the wave power resource in the world is of  $2 \times 10^{12}$  W. Corresponding to the annual usable energy of  $1.75 \times 10^{13}$  kW • h electricity, it almost equals the annual electricity consumption of the world.<sup>7</sup>

#### 2.1.6 Tidal Energy

The worldwide theoretical tidal energy reserve is of  $3 \times 10^9$  kW.<sup>8</sup> Currently there is only a small number of tidal power plants put into operation for commercial use. The main factor restricting tidal energy generation progress is that the cost per kW of tidal power station is higher than that of conventional power.

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<sup>6</sup> Ibid.

<sup>7</sup> ZUO, op. cit. p.350.

<sup>8</sup> GUO, op. cit. p.182.

### 2.1.7 Ocean Osmotic Energy

It is estimated that, using ocean osmotic energy for power generation, the annual worldwide power generation capacity could reach 1.6 trillion kW • h.

### 2.2 The Depth Space of “New Ocean” — Outer Space

Earth is very far from the Sun (average distance of  $1.5 \times 10^8$ km), and the space between the earth and the sun is a vacuum. Solar radiation is several times higher in space than that on the ground. In the universe, due to air damping and attraction, almost all high-energy heavy particles, in particular, disappear when they reach the ground, but they are very abundant in space.

Solar energy received by Earth per second is equivalent to that of 5 million tons of high-quality coal. Solar power is not only a primary energy, but also a renewable one. Solar power devices turn solar power into electricity; space conversion device converts electricity to microwave or laser and then send them to beam to the ground via antennae; ground receiving system can collect the beam from space via antenna, and then convert it into electricity. Using solar power to generate electricity in space can obviate problems including erecting transmission lines, fuel, traditional logistics transportation and pollution to the environment. It

is reported that in the United States, Japan and other space powers, the feasibility of building space power plants is being studied, and could eventually lead to having a power satellite sent into space to develop new energy sources. The sun is an inexhaustible clean energy treasurehouse, and using solar power fully is promising.

### 3. Definitions of Ocean Space's Breadth and Depth

#### 3.1 Definitions of Ocean Space's Breadth and Depth

With social progress and development, the control of renewable energy and resources belong to resources control, which could not be found in recent times. From the perspective of resources control, the Modern Ocean can be further divided into breadth space and depth space. Both of the two are characterized with "unlimited" extension. The so-called breadth of ocean space merely refers to the ocean space. From microscopic space to the entire marine space, all can be called the breadth of ocean space. To some extent, the ocean development can also be understood as developing space, outer space and the "new ocean" space. Therefore, the breadth space also includes outer space and it is nearly "unlimited". The so-called depth of ocean space refers to the development of ocean wind energy, solar power and other renewable energies and resources. Because these renewable energies and other resources are inexhaustible, the "depth" is unlimited. Therefore, the depth development is also

nearly "unlimited". In future, the development and utilization of solar power and other renewable energies and resources in space can also be included in the development and utilization of depth space.

Depth space resources are not just limited to ocean and "new ocean"; land is also abundant with wind power, solar power and other renewable energies and resources. Therefore, depth space resources also exist on land. Moreover, the recycling and utilization of scrap iron and steel, petrochemical products, etc. relates to the development and utilization of depth space. The depth space of resources such as rice, wheat and cotton etc., is actually the classical representative of the extension of depth space on one point which humankind is familiar with. Ocean depth space refers to the depth of space in the ocean and "new ocean".

### 3.2 Differences and Characteristics of Breadth Space and Depth Space

In political geography, differences and characteristics of breadth space and the depth space of the ocean and "new ocean" are: breadth space belongs to "outward" development while depth space belongs to "inward" development. In other words, breadth space is the continuous extension on a "line" while depth space is the continuous extension on a "point". The "outward" and "horizontal" development of breadth space is often accompanied by contradictions and conflicts

between nation and nation, nation and environment and humankind and nature. The “inward” and “vertical” development of depth space is a type of environment-friendly and sustainable development. The industrial achievements of breadth and depth space are all universal and can generate business and communications (Figure 1).

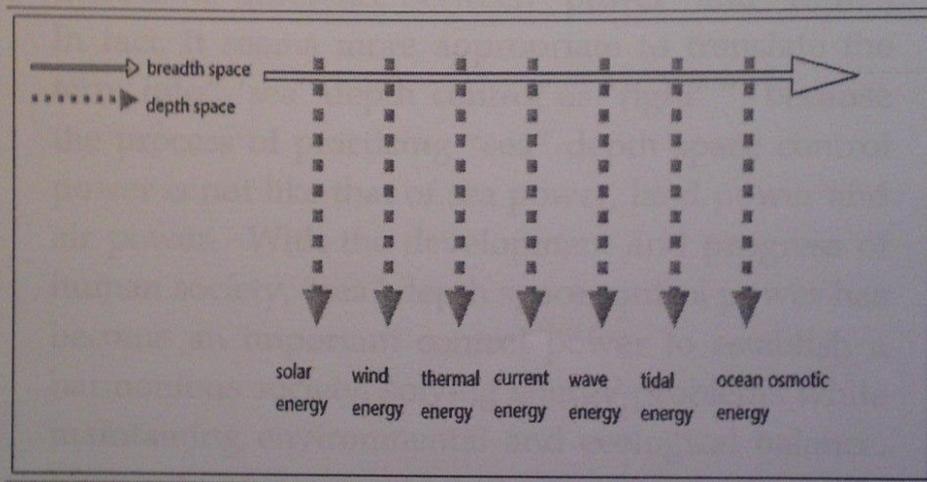


Figure 1 Breadth and Depth Space Spatial Relationship of Ocean and “New Ocean”

### 3.3 The Resources Control Scope Can also Be Expressed as the Sea Power Control in Modern Meanings.

The main objective of sea power control is ultimately to serve economic interests. Because of the process of productivity and of the impact of ecological environment and natural resources on humankind's activities in contemporary times, there has been a great change in the means of production and, indeed, in the whole concept of development. Uncontrolled development at the expense of the environment and of limited resources is more and more noncommendable. Hence, the rational and scientific way to obtain economic benefit is to develop ocean depth space, suggesting a new model of advanced development in a setting that is environmentally-friendly and sustainable. Therefore, controlling the depth of space resources can be translated as "sea power" control in a modern sense.

National interests include survival interests, security interests and development interests, the highest goals for a nation and its people. Depth space interests include survival interests, security interests and development interests, all contributing to the welfare of humankind.

To develop energy and other resources of ocean and "new ocean", nations should work

together; gradually understanding and strengthening the meaning of controlling the ocean depth space control.

### 3.4 On the Translation of the Noun Term "Sea" Depth Space Control Power

In Chinese, "Quan" is a single word and there is no difference between "power" and "right". In fact, it seems more appropriate to translate the term into " 'sea' depth control as 'right' ", because the process of practicing "sea" depth space control power is not like that of sea power, land power and air power. With the development and progress of human society, "sea" depth space control power has become an important control power to establish a harmonious society, solving energy problems while maintaining environmental and ecological balance. Moreover, to some extent, the serious deterioration of the Earth's environment also needs us, all the villagers in the global village, to carry out the "sea" depth space control power self-consciously, strictly and actively, while helping to maintain the security of humankind and of nature and its resources.

#### 4. Pay Attention to the Harmonious Marine Environment in the Future

##### 4.1 Emphasizing the Research on Ocean and "New Ocean" Harmonious Environment in the Future.

Energy development followed the growth of human society. From firewood energy at the dawn of time, and after the coal period during the Industrial Revolution, energy has entered today's fossil-based fossil energy era. Rapid economic growth stimulates man's desire to possess and conquest nature. While creating economic miracles one by one, we have edged progressively toward disaster. With the crisis in resources, ecology and food, human societies today face the serious challenges of sustainable development.

Materials of ocean and "new ocean" do not exist in isolation, as they all interact. For centuries, people observed the only ocean and "new ocean" from the surface of land or ocean. In modern times, people observe ocean and "new ocean" through advanced technologies such as radio telescopes, satellites, spacecrafts, deep-sea submersibles, remote sensing technologies, and so on. Even so, the information people get by sampling via spacecraft and deep-sea submersible is only sporadic. Most advanced ocean remote sensing technology today still cannot observe the deep-sea water layer average separated by 3800m.

For the deep sea and the vast expanse of the universe, a century and a millennium are just short moments, but for us humans, it is one whole life relayed to us by past generations. To us, the ocean and "new ocean" are an unfamiliar environment. In 1938, scientists invented DDT<sup>9</sup> which contributed much to agricultural production, weeding, pesticides and household mosquito and fly disinfestations. That invention won the Nobel Prize in 1948.

However, PCBs<sup>10</sup> and other organic residues of the new technology had a great impact on environmental safety and are so far still difficult to eradicate. Since the 1960s, international organizations enacted a comprehensive ban on the use of DDT and BHC<sup>11</sup>. From the point of environmental safety, scientists learned a good lesson and finally the use of these pesticides was halted. To protect the health of humanity and to respect the laws of nature, when developing the ocean and "new ocean" space we must evaluate in exploration and research the impact of new development on the sustainability of the ocean and of the "new ocean".

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<sup>9</sup> Dichlorodiphenyltichloroethane.

<sup>10</sup> Polychlorinated buphenyls.

<sup>11</sup> Benzene hexachloride

#### 4.2 Development and Utilization of "New Ocean". "New Ocean" is a New Field in Today's International Cooperation and Competition.

"New Ocean" and the ocean have been seriously polluted because of mountains of garbage. However, it is only a few decades old for outer space development where there has been no shortage of resources satellite orbit and orbital trash. NASA researchers believe the space junk is getting more and more, which will leave unburdened danger to the space. Even if no space shuttle is launched, by 2055, the number of new pieces produced by the collision will surpass the total number of pieces burnt out when falling back to the Earth's atmosphere. Using international space stations as an example, the possibility for them, in the next ten years, to seriously collide with space junk is as high as 50%.<sup>12</sup>

Compared to the universe, humankind's world is very tiny. Just as the cells and bacteria in the body swallow the healthy cells and bacteria, resulting in illness, so over-exploitation and overuse of limited resources in the universe would destroy our one Earth. We should therefore act as "cells" or

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<sup>12</sup> ZHU Weiwei. NASA: *Space junk approaching critical tipping point.*

<http://www.sciencenet.cn/sbhtmlnews/200710152156817191606.htm>  
?id=191606 (2007-10-15)

"bacteria" which contribute positively to the universe.

Although space resources are very rich, they cannot withstand uncontrolled and destructive development. To the "new ocean" beyond our land humankind's development of space resources cannot be predatory, as a kind of colonial development, barbaric and disorderly as happened in the Middle Ages, and even in more 'enlightened' recent centuries.

#### 4.3 The R & D of Depth Space should be Highlighted when Developing the Breadth and Depth Space of Ocean and "New Ocean".

In ocean and "new ocean", there are both limited and renewable and environment-friendly energies and other resources to be researched and developed. For example: combustible ice and helium-3 are the new energies in ocean and "new ocean" enjoying huge, if limited, reserves. Exploration and research shows that the distribution area of combustible ice accounts for 10% of the total ocean area, equivalent to  $4 \times 10^7$  km<sup>2</sup>, making it the most valuable mineral resources under the sea. The main approaches to extract natural gas from combustible ice are thermal excitation, chemical reagent and decompression. Considerable research is necessary to apply these methods to large scale

production. However, we should be aware that the negative impact of the development of this resource may cause large amounts of methane to escape into the atmosphere, where the greenhouse effect would be much higher than that of carbon dioxide.<sup>13</sup> It is better to highlight the research and development of depth space than to put the limited and valuable input averagely on the research and development of breadth and depth space.

## 5. Significance of Actively Developing the Ocean Depth Space

### 5.1 The Significance for China to actively Develop the Ocean Depth Space.

America and World Bank experts predict that China's economic progress will catch up with that of the U.S.A. in the next 30 years. To reach such a goal cannot merely depend on the current economic development model which mainly depends on using the limited resources and polluting ecological environment. Through development of ocean depth space, a harmonious and friendly relation with the environment can be formed. Wind power, solar power and other renewable energies and resources are inexhaustible, as the "depth" is unlimited. It is, for China, as a developing marine country the main development field for technological innovation and

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<sup>13</sup> GUO, *op. cit.* pp. 187-190.

commercial production of ocean energy and other resources. Internationally, China should make efforts to become the main force to develop new ocean energy and embarking on innovative production, thus establishing a new national image of environmental protection and energy saving in an ocean context. In so doing, China can reduce its environmental emissions pressure and ease or solve the problematic supply of energy and related resources.

## 5.2 The Significance for the World to actively Develop Ocean Depth Space

In the twentieth century, world population grew from 1.6 billion to 6 billion, increased about 4 times; while during the same period, the annual world primary energy consumption increased 10-fold, from 2.0 billion tons of coal to 20 billion tons. At the current rate of consumption, the planet's proven reserves of fossil energy sources will be used up in 200 years.

The depth space economy of ocean and "new ocean" includes all the products, services and markets created by various depth space activities of ocean and "new ocean", through new technology, new products, culture industry and related industries using depth space energy and of ocean and "new ocean" resources.

Both for China and for the world, the equitable and sustainable use of these resources will carry important strategic significance in developing international economic relations through the sustainable progress of humankind as a whole.

### Biographical Note

Yiming Cai majored in maritime economics and geopolitics, and is adjunct Professor of the School of Management, Zhejiang Ocean University, China, and senior economist to the Port of Zhoushan Authority, China.

He has proposed several distinctive theories, including "Three-stage Theory of Harmonious Ocean", "On the Breadth of Space and the Depth of Space for 'Ocean' Development" and "Control Rights of the Ocean's Deep Space". Based on recent developments, in his study on new geopolitics, economics and use of resources, he examines the existing harmony both between nation and nation, and between mankind and nature. Breadth and Depth Space Theory belongs to the new geopolitics aimed at resolving resources and environment problems, and encompassing a harmonious and peaceful development of human society.

He has published more than 50 academic articles in China's academic and professional journals, and is currently finalising a book on maritime affairs.

### An Uncommonly Good Man

Salvino BUSUTTIL



Guido de Marco, Salvino Busuttill

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# TELOS

## Volume V

In commemoration of Guido de Marco's dedication to the international dimension of maritime affairs, Fondation de Malte felt it would be a fitting tribute to focus on a particular moment of de Marco's life, in his involvement in the Independent World Commission on the Oceans (IWCO) as one of its prestigious Vice-Presidents. The maritime context, both from a national and international perspective, remained for him an essential dimension to any geopolitical progress.

"...if I were to describe my father's character, I would probably have to refer to the character of Santiago in Hemingway's novel *"The Old Man and the Sea"*. Indeed his character reminds me so much of the sea; calm, yet forceful. That he had such commonality with the sea is not a surprise for many who know the stuff that islanders are made of, especially those islanders who are raised in hope despite not knowing what tomorrow will bring."  
*Mario de Marco*

"President Guido de Marco, with his high qualities as a statesman and as a respected political figure, always impressed me through the years we shared together, initially more formally and, with time, through a friendship reinforced by a common point of view concerning several issues which confronted both of us, as citizens attentive to the pulse of our societies and of the world."  
*Mário Soares*

"I had the great good fortune to know, work with, and learn from Guido de Marco who maintained in his distinguished professional life the same ideals of integrity and commitment that made his friendship at once satisfying and inspiring. It is rare in my experience to encounter someone who has attained the heights of public recognition, becoming both president of his country and of the United Nations General Assembly, and yet so consistently exhibited social modesty and an earthy sense of humility."  
*Richard Falk*



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## TELOS Volume V - 封底

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## Profiles of the Company and Its Founder

Yiming Cai, male, is a researcher professor and legal representative of Shanghai All-heart Environment Development Center. During the period of working in the Shipping Administration of Zhoushan Port (Shanghai Office), he created and completed a monograph on the theory of frontier disciplines of Multi-dimensional Space Resources Science in spare time. He also created the theory of “Depth Space Control Power” of new geopolitics and “Evolution of Human Development Resource Utilization Broad and Deep Space” from the perspective of resource utilization. His research interests include basic and applied theories of resources and environment, geopolitics and economic development. It's original and innovative. The core content of the published papers by Mr. Cai on the science of Multi-dimensional Space Resources Science was identified by the Science and Technology Novelty Search Workstation of the Ministry of Education, and proved no other authors have put forward or discussed similar ideas in domestic and foreign literature reports. It is worth mentioning that in 2011, the special issue of TELOS International Academic Series commemorating the outstanding contributions international maritime affairs made by the former President of Malta and President of the 45th Session of the United Nations General Assembly, De Marco, included Mr. Cai's full core theories in Multi-dimensional Space Resources Science. The other 10 authors of this special issue are all internationally influential experts and scholars. In this special issue, they talked about De Marco's outstanding contribution to the ocean, but only Yiming Cai talked about his core theory of Multi-dimensional Space Resources Science. While remembering the important contribution made by De Marco to the Marine cause, the special issue also expressed high recognition and attention to the new theory of frontier disciplines proposed by Mr. Cai.

Researcher professor Yiming Cai has written and published *Multi-dimensional Space Resources Science*, a monograph on the original frontier discipline theory. More than 80 papers of his are published in international, national and provincial professional and academic journals. He has also presided over or participated in eight international, national and provincial key subjects (projects). *Global Times* (English version), *China Ocean News*, *Zhejiang Daily*, *People's Daily*, Xinhua News Agency and many other media have publicized and reported related theories in Multidimensional Space Resources for several times.

Shanghai All-heart Environment Development Center is a private enterprise founded by Yiming Cai, the researcher professor of Multi-dimensional Space Resources. The center focuses on the sustainable development of resource utilization. It combines the frontier discipline theory of “Multi-dimensional Space Resource Science” founded by researcher professor Yiming Cai and the new geopolitics theory of “Deep Space Control Power”, as well as the “Evolution of Human Development Resource Utilization Broad and Deep Space” proposed from the perspective of resource utilization. With the website of the Center as the carrier, the **goal** is to build an influential and distinctive platform for domestic and international information, academic exchange (including education) and think tank in the field of environmental protection and sustainable development. The development of new productive forces is also reflected in dimensional operation. According to the characteristics of resource utilization, multi-dimensional space resource science applies the four-dimensional space of resource utilization evenly to the basic theory and applied theory of natural science, geopolitics and economic development.

Shanghai All-heart Environment Development Center was newly registered in November 2020. The website has been online, still under construction. Stay tuned!

Index: [www.xyhj-ahc.com](http://www.xyhj-ahc.com)