Marine Eco-damage Assessment Methods Based on the Eco-restoration Cost in China

Dr. Keliang Chen

Third Institute of Oceanography, MNR, China

Email: klchen@tio.org.cn

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1. Introduction

Marine Eco-damage

（1）It happened due to human activities, such as marine activities, coastal engineering, marine transportation, marine oil exploration and development, and island development, not including natural disasters.

（2）The causes of marine eco-damage include the change of natural conditions and the input of polluting substances or energy.

（3）It effects marine ecosystem (biological factors and non-biological factors).

Marine Eco-damage led to

- a sharp decrease in area of tidal flat and wet land,
- a series of ecological environment adverse effects(such as weakening in bay self-purification capacity, port and navigation channel siltation, beach degradation and beach erosion, damages of coastal landscape),
- decrease in marine fishery resources, biodiversity.

Why to assess marine eco-damage?

- Aims to establish the marine eco-damage compensation mechanism which is to constrict the enterprise consuming marine eco-environment resources, and to support and encourage the enterprises to adopt the environment-friendly production methods and intensive-efficient resource utilization.
- To assess the loss of marine biological and non-biological resources value when human beings are developing and utilizing the sea is the basis to implement marine eco-damage compensation.

Marine eco-damage compensation (MEDC)

- It is one kind of integrated environmental economic policy.
- Compensate to the marine ecosystem and private objects due to the damage caused by legal development activities and accidental oil spills or other hazardous substances or waste disposals using administrative and marketing approaches to balance rights and obligations of relevant parties during marine resources development and environmental protection.
- Aims to maintain marine ecosystem health, promote harmonious development between human and nature.

2. Marine Development Situation in China

The Status and Issues of Marine & Coastal Areas

The Pressure of Coastal Use and Development

- **Population increase in coastal areas**
  - 65% of total population lived in coastal provinces
  - The spatial pattern is inequality
- **Reclamation of tidal flats for agricultural and industrial uses**
  - From 1980s to 2017, about 12,000km^2
- **Intensity of development activities and the emergence of new use activities in the coastal areas**
  - increasing needs for industrial, ports and islands tourism uses
  - ocean energy complexes. ex wind, wave, current, tidal power
- **Deepening conflicts on the value of conservation and development**


辽宁沿海经济带
天津滨海新区
长三角地区
海峡西岸经济区
珠三角地区
广西北部湾经济区


辽宁沿海经济带
河北沿海地区
曹妃甸循环经济示范区
天津滨海新区
综合配套改革试验区
山东半岛
蓝色经济区
江苏沿海地区
长江三角洲地区
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广西北部湾经济区
珠江三角洲地区
广东海洋经济
综合试验区
1 Liaoning
2Tianjin
11 Shanxi
9 Sichuan
10 Hubei
3 Shanghai
8 Chongqing
4 Zhejiang
5Fujian
6 Guangdong
7 Hainan
11 Pilot Free Trade Zones

Major Conflicts

- Pollutions;
- Coastal line changes in sea/coastal areas use by ports, industry and tourism;
- Overfishing, over-exploitation;
- Invasion of alien species;
- Serious degeneration of marine ecosystems health;
- Erosion and siltation.

3. Related Laws and Guidelines in China

Environmental Protection Law of the People's Republic of China(Amended in 2014)

- Article 5. Activities concerning environmental protection shall adhere to the following principles: according priority to protection, emphasis on prevention, integrated governance, public participation and liability of damages.
- Article 6. All units and individuals shall have the obligation to protect the environment. Enterprises, public institutions and any other producers/business operators shall prevent and reduce environmental pollution and ecological destruction, and shall bear the liability for their damage caused by them in accordance with the law.
- Article 30. Exploitation and utilization of natural resources shall be developed in a rational way that conserves biological diversity and safeguards ecological security. Ecological protection and restoration programs shall be developed and implemented in accordance with laws .

Marine Environment Protection Law of the People's Republic of China（Revised in 2017）

- Article 20. Efforts shall be made to renovate and restore damaged marine ecosystems having important economic and social values.
- Article 24. Establish and improve the nation's marine ecological protection compensation system. The development and utilization of marine resources shall…… not cause marine ecological environment destruction.

Marine Islands Protection Law of the People's Republic of China（2009）

Article 25. For ecological damage caused by engineering construction, the unit and individual shall be responsible for repair; Unable to repair, they shall be ordered to stop the construction by the governments, and the relevant departments can be designated to repair the damaged ecosystem.

The Environmental Impact Assessment Law of the People's Republic of China （Revised in 2016）

Article 2. Environmental impact assessment as used in this Law refers to the method and system for conducting analysis, prediction and assessment on the environmental impact that might arise from implementation of plans and construction projects, putting forward countermeasures and measures for preventing or alleviating adverse environmental impact, and performing follow-up monitoring.

Regulations for the prevention and control of marine environmental pollution damage caused by marine construction projects （2006）

Article 8. The state shall practice a system of ocean engineering environmental impact assessment. Environmental impact assessment of marine engineering shall carry out comprehensive analysis, prediction and assessment with emphasis on the effects of the engineering on marine environment and marine resources, and put forward the corresponding ecological protection measures to prevent, control or reduce the impact of engineering on marine environment and marine resources.

Some Chinese Laws referred to MEDA

- *Environmental Protection Law*
- *Marine Environmental Protection Law*
- *Island Protection Law*
- *Environmental Impact Assessment Law*
- *Sea Areas Use Law*
- Law of Port

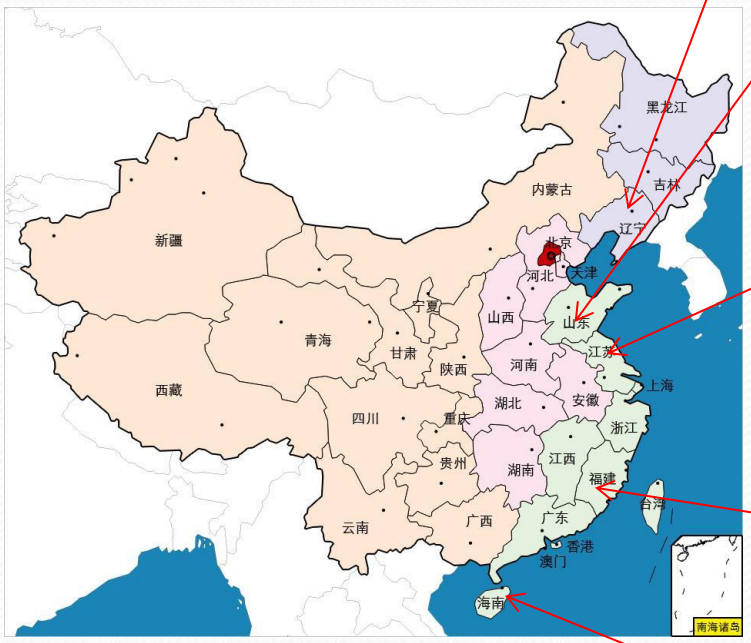
Principle: "Who develops who protects, who damages who compensates"

- "who develops who protects" stresses on the obligation to protect the ecological environment during development and utilization.
- "who damages who compensates" stresses on the obligation to renovate, restore or pay for repair of damaged marine ecological environment, similar to "polluter pays".

Relevant technical guidelines for assessment

- GB/T 21678-2018: Calculating methods on the economic loss of fishery pollution accidents.
- GB/T 34546.1-2017 : Technical guides for marine eco-damage assessment - part 1: General;
- GB/T 34546.2-2017 : Technical guides for marine eco-damage assessment - part 2: Marine oil spill;
- GBT 19485-2014:Technical guidelines for environmental impact assessment of marine engineering;
- GB/T 28058-2011: Technical guidelines for marine eco-capital assessment;
- SC/T9110—2007: Technical regulations for impact assessment of construction projects on marine living resources.

- DB37/T 1448-2016： Technical directives for assessment of compensation for marine eco-loss caused by marine construction projects (Shandong);
- DB21/T 2150-2013： Technical guideline for Marine biological damage assessment of marine (coastal) engineering in Liaoning;
- DB12/T 548-2014 : Evaluation method of marine eco-damage of marine (coastal) engineering in Tianjin;
- DB46 / T 238-2013： The marine eco-damages reparation and ecological compensation evaluation method of Hainan Province.



Liaoning Province

Technical guideline for Marine biological damage assessment of marine (coastal) engineering in Liaoning

Shandong Province

Technical directives for assessment of compensation for marine eco-loss caused by marine construction projects

Jiangsu Province

Marine living resources damage compensation and loss compensation evaluation method in Jiangsu Province

Fujian Province

Compensation standards on eco-damage of sea-related development activities of Xiamen

Hainan Province

The marine eco-damages reparation and eco-compensation evaluation method of Hainan Province

4. Technical guides for marine eco-damage assessment - part 1: General (GB/T 34546.1-2017)

ICS 07.060;13.020.10
E 01

中华人民共和国国家标准

GB/T 34546.1—2017

海洋生态损害评估技术导则
第1部分:总则

Technical guides for marine ecological damage assessment—
Part 1:General

2017-10-14 发布　　2018-02-01 实施

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中国国家标准化管理委员会　发布

目　次

(1) Goal

- It aims to standardize the value assessment of marine eco-damage, to ensure MEDA scientific and normal.
- It provides an assessment procedure, methods, contents and requirements of marine eco-damage, caused by marine development activities and environmental emergencies, and technical support for the marine administrative department to carry out the national marine eco-damage compensation.

(2) Assessment methods

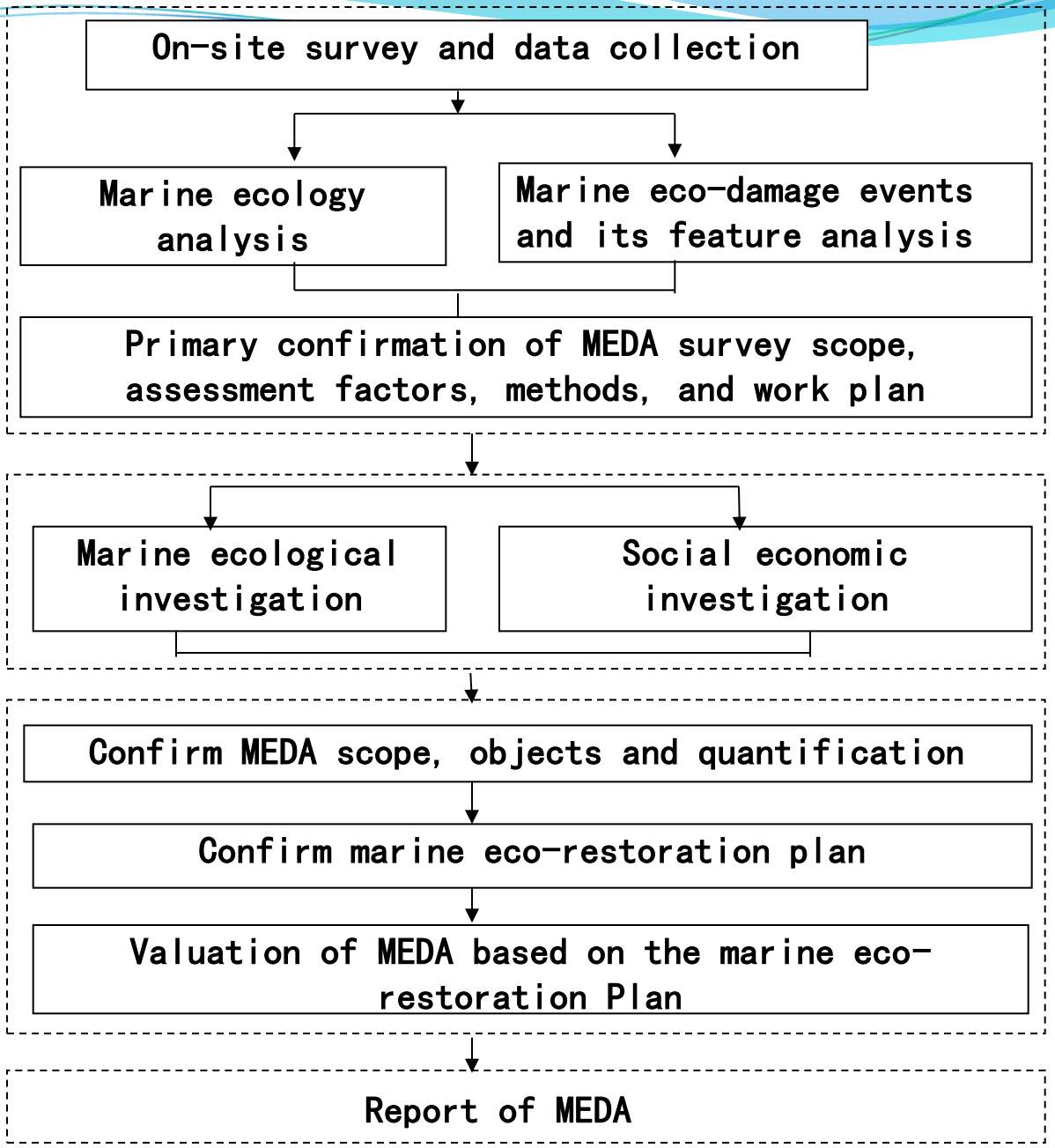
Types	Methods
Method based on eco-restoration	Natural Resource Damage Assessment (NRDA), Habitat Equivalency Analysis (HEA)
Method based on ecosystem services	Conventional market evaluation method, Alternative market evaluation method, Hypothetical market evaluation method.
Simple method	Fixed numerical method

The general idea of marine eco-damage assessment in this guideline is based on the account of eco-restoration cost.

Assessment method based on eco-restoration cost

- It is a very reasonable objective to restore the damaged natural resources to an undamaged status, which can be easily accepted;
- There are lots of practices to be learned, including judicial practice for reference;
- The damaged marine ecosystem with important economic and social value should be treated and restored—the Marine Environmental Protection Law of China;
- Marine eco-damage assessment is the basis for ecological restoration, that is, assessment is the means and process, and restoration is the final goal and result.

(3)Road map


Preparation phase
On-site survey and data collection
Marine ecology analysis
Marine eco-damage events and its feature analysis
Primary confirmation of MEDA survey scope, assessment factors, methods, and work plan
Investigation phase
Marine ecological investigation
Social economic investigation
Analysis and evaluation
Confirm MEDA scope, objects and quantification
Confirm marine eco-restoration plan
Valuation of MEDA based on the marine eco-restoration Plan
Report preparation
Report of MEDA

（4）Contents of MEDA valuation

（1）Costs for the marine ecological restoration;

（2）Costs in recovery period (for example marine biological resources, marine environmental carrying capacity);

（3）Costs for the preventive/alleviative measures (such as pollution cleaning and damage reduction activities);

（4）Other reasonable costs in monitoring, test and evaluation etc.

Type	MEDA contents				
	Costs for marine ecological restoration	Eco-loss Costs in recovery period		Costs of preventive/ alleviative measures	Other reasonable costs like monitoring
		Loss of marine environmental carrying capacity	Loss of marine biological resources		
Marine development activities	★	★	★	◎	★
Marine environmental emergencies	★	★	★	★	★
★yes，◎no					

1）Costs for the marine eco-restoration

$$F = F_G + F_S + F_T + F_Q$$

F——The total cost for marine ecological restoration;
F_G——Project costs (the direct project costs for habitats reconstruction such as water body and sediment);
F_S——Costs to buy devices and materials for the species' supplements ;
F_T——Costs to buy land (sea area) for alternative projects construction;
F_Q——Other restoration costs (including investigation, restoration planning, monitoring and effective assessment, etc.).

2）Costs in recovery period

①marine biological resources:
fishery resources； rare and endangered aquatic wildlife； other biological resources.

②marine environmental carrying capacity

Area less than 3 km²

$$Q_i = V(C_s - C_i) \times 10^{-6} + K\Delta V(C_s - C_i) \times 10^{-6}$$

When the polluted sea area is less than 3km^2, the following formula is used to simplify the calculation：

$$Q_i = V(C_s - C_i) \times 10^{-6} + K\Delta V(C_s - C_i) \times 10^{-6}$$

Q_i——Loss amount of environmental capacity of No.i pollutant（t）；
V——Volume of the affected sea area（m^3）；
ΔV——The amount of net outflow of affected sea water in a tidal cycle （m^3），
$\Delta V=Sd$，S-surface area of sea area，d-tidal difference；
K——Water exchange rate of the affected sea area, $K=T/t$，t, tidal period，T, investigation period；
C_s——Concentration of No. i pollutant of the affected sea area after the damage event occurs,（mg/L）
C_i——Background concentration of No. i pollutant（mg/L）。

The numerical simulation or other proven methods in recovery period are encouraged to be adopted to calculate the loss of marine environment capacity resulting from the changes in self-purification such as pollutant discharge into the sea, water exchange or biochemical degradation, the investigation or the recent monitoring test data used for verification .

3） Costs for preventive/alleviative measures

Mainly include the emergency disposal costs and pollution cleaning costs.

——disposal costs for emergency monitoring, test, emergency disposal devices and personnel etc.;

——cleaning costs for pollution cleaning devices and materials, personnel, transportation and disposal of pollutants.

4）Other reasonable costs

The relevant rational costs covered the monitoring, test and assessment consultant service for marine eco-damages according to the national charging criteria.

	Total Costs
(1)	Costs for the marine ecological restoration
(2)	Costs in recovery period
(3)	Costs for preventive/alleviative measures (such as pollution cleaning and damage reduction)
(4)	Other reasonable Costs（monitoring, test and assessment）

A simple case study

- Total length is 501 m, running from northwest to southeast;
- Reclamation area is about 18 682.5m^2;
- This project occupies 2.52 hm^2 sea area, and 476 m used coastline.

Items	Project	Costs (RMB)
（1）The costs for the marine ecological restoration	Costs to buy devices and materials	155 400
	Costs to buy sea areas	78 600
	Other restoration costs	100 000
（2）The costs in recovery period	Marine environment capacity loss	98 550
	Marine life loss	233 100
（3）The costs for the preventive measures	Pollution cleaning & damage reduction	None
（4）Other reasonable costs	Monitoring cost	50 000
	Assessment cost	100 000
total	Costs of marine eco-damages	815 650 (114,880 USD)

Shandong Province

- Marine eco-compensation fee under MEDA is US $ 50 million collected from 2011 to 2014 in Shandong province including 6 coastal cities;
- More than 300 projects for the use of sea areas approved.
- US $ 19 million of the compensation fee for funding 35 marine ecological restoration projects.

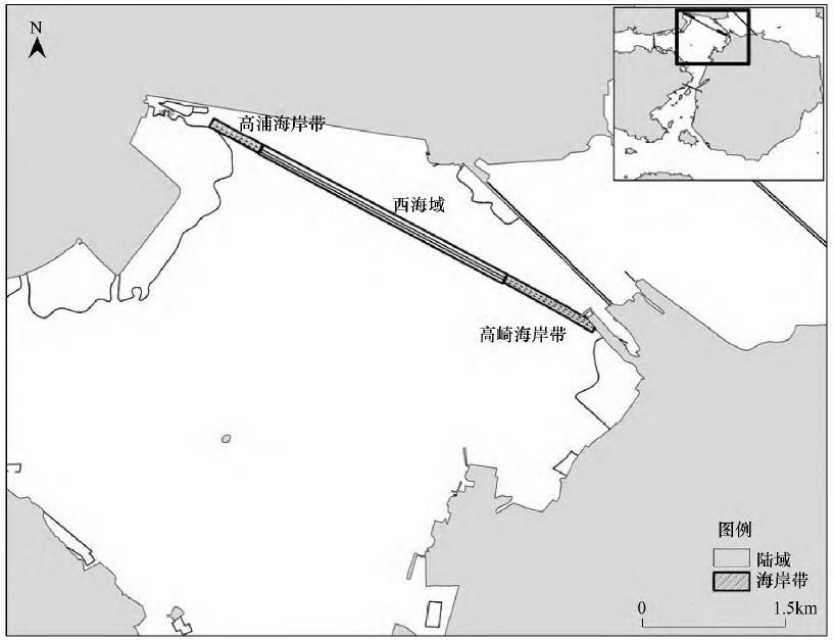
Guangdong Province

The Hongkong-Zhuhai-Macao Bridge (estimated total investment US $ 11.73 billion) provided marine eco-protection compensation fees for the marine living resources of US $ 30.24 million under MEDA.

Hongkong-Zhuhai-Macao Bridge (55 km)

Fujian Province

Group of the cross-sea bridge project provided eco-protection compensation fee to Xiamen government. (US $ 0.75 million totally) under MEDA.



5. Summary

(1) The technologies and policies of the marine eco-damage compensation are in the developing progress.

(2) The public and the government pay more attention to the marine eco-damage compensation gradually.

(3) From China's national context, to collect marine eco-damage compensation fees paid by sea-related projects are effective.

(4) The marine development and utilization activities should be required to do the MEDA and MEDC in EIA.

(5) More practical assessment method, standards and procedure of marine eco-damages and losses for different marine development activities or events should be established soon.