IMPLEMENTING THE STRATEGIC ACTION PROGRAMME FOR THE YELLOW SEA LARGE MARINE ECOSYSTEM: RESTORING ECOSYSTEM GOODS AND SERVICES AND CONSOLIDATION OF A LONG-TERM REGIONAL ENVIRONMENTAL GOVERNANCE FRAMEWORK

(UNDP/GEF YSLME Phase II Project)

# Two management plans including monitoring programs and capacity development program


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# 1. Background

The Yellow Sea is located between China and Korea. The name is given to the northern part of the East China Sea, which is a marginal sea of the Pacific Ocean. It is located between mainland China and the Korean Peninsula. Its name comes from the sand particles from Gobi Desert sand storms that turn the surface of the water golden yellow.

The innermost bay of the Yellow Sea is called as the Bohai Sea (previously Pechihli Bay or Chihli Bay). Into it flow both the Yellow River (through Shandong province and its capital Jinan) and Hai He (through Beijing and Tianjin). Deposits of sand and silt from those rivers contribute to the sea colour.

The northern extension of the Yellow Sea is called the Korea Bay.The Yellow Sea is one of four seas named after common colour terms — the others being the Black Sea, the Red Sea and the White Sea.Since 1 November 2018, the Yellow Sea has also served as the location of "peace zones" between North and South Korea.

The Yellow Sea, excluding the Bohai, extends by about 960 km (600 mi) from north to south and about 700 km (430 mi) from east to west; it has an area of about 380,000 $km^2$ (150,000 $mi^2$) and the volume of about 17,000 $km^3$ (4,100 $mi^3$). Its depth is only 44 m (144 ft) on average, with a maximum of 152 m (499 ft). The sea is a flooded section of continental shelf that formed after the last ice age (some 10,000 years ago) as sea levels rose 120 m (390 ft) to their current levels. The depth gradually increases from north to south. The sea bottom and shores are dominated by sand and silt brought by the rivers through the Bohai Sea (Liao River, Yellow River, Hai He) and the Korea Bay (Yalu River). Those deposits, together with sand storms are responsible for the yellow water color and the name. Major islands of the sea include Anmado, Baengnyeongdo, Daebudo, Deokjeokdo, Gageodo, Ganghwado, Hauido, Heuksando, Hongdo, Jejudo, Jindo, Muuido, Sido, Silmido, Sindo, Wando, Yeongjongdo and Yeonpyeongdo (all in South Korea).

The area has cold, dry winters with strong northerly monsoons blowing from late November to March. Average temperatures in

January are −10 °C (14 °F) in the north and 3 °C (37 °F) in the south. Summers are humid and warm with frequent typhoons between June and October. Air temperatures range between 10 and 28 °C (50 and 82 °F). The average annual precipitation increases from about 500 mm (20 in) in the north to 1,000 mm (39 in) in the south. Fog is frequent along the coasts, especially in the upwelling cold-water areas.

The sea has a circularly warm current. It is a part of the Kuroshio Current, which diverges near the south western part of Japan and flows northward into the Yellow Sea at the speed of below 0.8 km/h (0.50 mph). Southward currents prevail near the coast line, especially during the monsoon period in winter.

Brown sediment spills out into the Yellow Sea from rivers in eastern China and Korea. The nutrients in the sediment may be responsible for the bloom of phytoplankton seen as blue-green swirls. The water temperature is close to freezing in the northern part in winter, so drift ice patches and continuous ice fields form and hinder navigation between November and March. The water temperature and salinity are homogeneous across the depth. The southern waters are warmer at 6–8 °C (43–46 °F). In spring and summer, the upper layer is warmed up by the sun and diluted by the fresh water from rivers, while the deeper water remains cold and saline. This deep water stagnates and slowly moves south. Commercial bottom-dwelling fishes are found around this mass of water, especially in the southern part. Summer temperatures range between 22 and 28 °C (72 and 82 °F). The average salinity is relatively low, at 30‰ in the north to 33–34‰ in the south, dropping to 26‰ or lower near the river deltas. In the southwest monsoon season (June to August) the increased rainfall and runoff further reduce the salinity of the upper water column. Water transparency increases from about 10 meters (33 ft) in the north up to 45 meters (148 ft) in the south.

Tides are semidiurnal, i.e. rise and fall twice a day. Their amplitude varies between about 0.9 and 3 meters (3.0 and 9.8 ft) at the coast of China. Range of tides are bigger in the Korean Peninsula, typically ranging between 4 and 8 meters (13 and 26 ft) and reaching the maximum in spring. The tidal system rotates in a counterclockwise direction. The speed of the tidal current is generally less than 1.6 km/h (0.99 mph) in the middle of the sea, but may increase to more than 5.6 km/h (3.5 mph) near the coasts. The fastest tides reaching 20 km/h (12 mph) occur in the Myeongnyang Strait between Jindo and the Korean Peninsula.

The tide-related sea level variations result in a land pass 2.9 km (1.8 mi) long and 10–40 meters (33–131 ft) wide opening for approximately an hour between Jindo and Modo. The event occurs about twice a year, at the beginning of May and in the middle of June. It had long been celebrated in a local festival called "Jindo Sea Parting Festival", but was largely unknown to the world until 1975, when the French ambassador Pierre Randi described the phenomenon in a French newspaper.

The sea is rich in seaweed (predominantly kelp, *Laminaria japonica*), cephalopods, crustaceans, shellfishes, clams, and especially in blue-green algae which bloom in summer and contribute to the water color (see image above). For example, the seaweed production in the area was as high as 1.5 million tonnes in 1979 for China alone. The abundance of all those species increases toward the south and indicates high sea productivity that accounts for the large fish production in the sea. New species of goby fish was also discovered.

The southern part of the Yellow Sea, including the entire west coast of Korea, contains a 10 km-wide (6.2 mi) belt of intertidal mudflats, which has the total area of 2,850 $km^2$ (1,100 $mi^2$) and is maintained by 4–10 m (13–33 ft). Those flats consist of highly productive sediments with a rich benthic fauna and are of great importance for migratory waders and shorebirds. Surveys show that the area is the single most important site for migratory birds on northward migration in the entire East Asian – Australasian Flyway, with more than 35 species occurring in internationally significant numbers. Two million birds, at minimum, pass through at the time, and about half that number use it on southward migration. About 300,000 migrating birds were transiting annually only through the Saemangeum tidal flat area. This estuary was however embanked by South Korea in 1991–2006 that resulted in drying off the land. Land reclamation also took 65% of the intertidal area in China between the 1950s and 2002, and there are plans to reclaim a further 45%.

Oceanic megafaunas bio-diversities, such as of marine mammals, sea turtles, and larger fish drastically decreased in modern time not only by pollution but also mainly by direct hunting, most extensively Japanese industrial whaling, illegal mass operations by Soviet with supports from Japan and fewer species survived to today although being still in serious perils. Those include spotted seals, and cetaceans such as minke whales, killer whales, false killer whales, and finless porpoises, but nonetheless all the remnants of species listed could be in very small numbers. Historically, large whales were very abundant either for summering and wintering in the Yellow and Bohai Seas. For example, a unique population of resident fin whales and gray whales were historically presented, or possibly hosted some North Pacific right whales and Humpback whales (3 whales including a cow calf pair was observed at Changhai County in 2015) year-round other than migrating individuals, and many other migratory species such as Baird's beaked whales. Even blue whales, Japanese sea lions, dugongs (in southern regions only) and leatherback turtles used to breed or migrate into Yellow and Bohai seas.

Spotted seals are the only one pinned species thriving in today's Yellow Sea and being the only resident species as well. A sanctuary for these seals is situated at Baengnyeongdo which is also known for local finless porpoises. Great white sharks have been spotted to prey on seals in these areas as well.

The Yellow Sea is being negatively impacted by human induced disturbances such as Harmful Algal Blooms (HAB), Jellyfish Blooms, nutrient enrichment causing eutrophication and climate change. These challenges are causing numerous deleterious consequences to the fishing and tourism industries and upsetting the overall balance of natural marine ecosystems.

Recently, due to the increase of pollution emissions, the seawater quality of the Yellow Sea has generally declined, the eutrophication of seawater has become more and more serious, and ecological disasters such as green tide and jellyfish outbreak have occurred frequently. According to China's 2018 Marine Environment Bulletin, the sea area of the Yellow Sea that did not reach the level 1 of seawater quality standard in 2018 was 26,090 $km^2$, a decrease of 2,130 $km^2$ compared with the same period of the previous year; the area of the inferior level 4 of water quality was 1980 $km^2$, an increase of 740 $km^2$ over the same period of the previous year. It is distributed in coastal waters such as the northern part of the Yellow Sea and the coast of Jiangsu. The main over-standard elements are inorganic nitrogen and active phosphate.

Green tide is a harmful ecological phenomenon caused by the explosive growth or high concentration of some large green algae in seawater under certain environmental conditions, which is regarded as the same as the red tide. The difference between green and red tides is that red tides are mostly caused by unicellular algae or protozoa, while green tides are caused by multicellular large algae. When the currents roll a large number of green tide algae to the coast, the green tide algae corrupt harmful gases, destroying the coastal landscape, and may also cause damage to the intertidal ecosystem.

In the Yellow Sea, the concrete manifestations are: the rapid propagation of large green algae such as canola, which covers a large area of the sea. Since 2008, the Yellow Sea in China has experienced a green tide disaster in the summer for 11 consecutive years. Although the moss is non-toxic, like the red tide, the large-bred canola can also shield the sun and affect the growth of other algae. The dead canola also consumes oxygen from the seawater. Studies have shown that the toxins secreted by canola are very harmful. It may also adversely affect other marine lives. The outbreak of canola will also seriously affect the landscape and interfere with tourism and water sports. This is the biggest adverse effect that people want to eliminate this time.

In the jellyfish-dominated ecosystem, jellyfish is another important source of dissolved organic matter. Jellyfish outbreaks cause changes in the flow of matter and energy in ecosystems. The continuous outbreak of large jellyfish (also known as *Nemopilema nomurai*) is one of the most typical disasters. Since the 1920s, the number of large-scale jellyfish outbreaks has been small, only once every 40 years (1920, 1958 and 1995). Since the beginning of this century, the frequency of outbreaks has increased significantly, showing an almost annual outbreak. (2002-2009, except 2008), however, in recent years since 2010 (2010 to 2015), the frequency of jellyfish outbreaks has decreased significantly.

In the years of outbreak, large jellyfish are widely distributed in the Bohai Sea, the Yellow Sea, the East China Sea and the East Sea, which pose serious threats to fisheries, industrial production and personal safety of coastal waters, and have also attracted the attention of neighboring countries. The Yellow Sea is one of the main areas of Chinese jellyfish outbreaks. It is mainly characterized by the early larvae of jellyfish distributed in the south bank of the Yangtze River estuary. In the later period, it may be affected by the Yellow Sea warm water mass. The Yangtze River dilute water gradually spreads to the north until it disappears after death. Large jellyfish have stinging cells that can cause harm to the human body. Therefore, the outbreak of jellyfish has also had a great impact on tourism. Some coastal tourist facilities have been closed due to the outbreak of jellyfish; the outbreak of jellyfish has caused serious damage to normal fishery production activities. The impact of the network equipment bursting, mesh congestion, resulting in reduced catch, increased fishing costs, fishermen's economic burden; jellyfish outbreaks will affect the coastal areas of some nuclear power plants, desalination plants, chemical plants, and even the normal operation of ships at sea, because these facilities require a large amount of sea water for cooling, and the jellyfish outbreaks can block the cooling system.

In 2009, a large number of sea-moon jellyfish in the northern part of the Yellow Sea invaded the Qingdao power plant and adhered to the filter network of the water circulation system, which almost caused the generator set to stop. In addition, the large jellyfish had a large food intake and spread rapidly, and there were almost no natural enemies. Jellyfish can extract a lot of energy from the food chain, so that the energy flow in the food chain is almost stagnant, and the jellyfish outbreak will affect the energy flow balance of the marine ecosystem.

## 2. Tasks

To address these threats it is imperative to study, understand and monitor impacts at national and regional levels, especially in coastal areas.

Through reliable and feasible technical methods, develop monitoring plans to improve the monitoring of marine debris, marine pollutants and marine water quality in the Yellow Sea region. Through the monitoring of plankton and jellyfish and other community structures in the Yellow Sea, the root causes of these marine ecological disasters are analyzed to provide early warning and prevention and control measures for marine disasters such as prevention and control of green tides.

# 3. Monitoring Programs

## 3.1 Harmful Algal Bloom Monitoring

Algal blooms are caused by nutrient rich waters, mostly due to agricultural run-off, where algae increase rapidly in number consuming excess nutrients and available oxygen. This creates 'dead zones' where no other aquatic life can survive. Although most are non-toxic, these outbreaks can lead to large imbalances in marine ecosystems, causing fish kills which jeopardize fisheries, and huge blooms which negatively affect tourism, as well as clog waterways.

The Regional HAB Monitoring Program (including macro-algae) will be managed by a regional committee to coordinate monitoring, assessment and data sharing of HAB occurrences. This committee will work together with the jellyfish committee to develop standardized national and regional monitoring methodologies for HAB.

Harmful algal blooms (HABs), sometimes known as "Green tide", occur when certain kinds of algae grow very quickly, forming patches, or "blooms", in the water. These blooms can emit powerful toxins which endanger human and animal health. Reported in every coastal state, HABs have caused an estimated $1 billion in losses over the last several decades to coastal economies that rely on recreation, tourism, and seafood harvesting. Blooms can lead to odors that require more costly treatment for public water supplies.

The green tidal algae that continue to be large-scale outbreaks in the Yellow Sea have been the green algae, the sarcophagus, and the *Ulva prolifera*. *Brassica* is a euryhaline and eurythermal seaweed, but its salinity and temperature required for growth have a certain range. In the proper growth environment, canola competes with other algae for its superiority, so it can shorten the breeding time and promote the large-scale rapid growth of algae, thus producing a large-scale green moss.

Since 2008, a large number of canola disasters have occurred in the Yellow Sea from May to August each year. The moss will consume excessive oxygen when it is multiplied, posing a threat to the growth and reproduction of other organisms on the seabed. It has an adverse impact; and a large area of canola floats on the shore near the sea, even drifting to the beach, it will also emit a foul smell after rotting, seriously affecting the development of coastal tourism. Therefore, the primary task of HABs monitoring in the Yellow Sea is to carry out effective monitoring and early warning of *Ulva prolifera*. At present, the green tide of the Yellow Sea has become the largest green tide disaster in the world. Due to its unique biological characteristics, canola has a clear advantage in competing with other seaweeds, leading to fulminant growth and formation of canola green tide. At present, it is urgent to verify and improve the effective and feasible floating algae health evaluation system to judge its growth status, health status and proliferative capacity.

The monitoring of the green tide and the canola in the Yellow Sea, the application of satellite remote sensing technology is crucial for clarifying the range, flow direction and biomass of the green tide. In order to better meet the needs of early warning monitoring of canola, satellite remote sensing technology has become a very important means for early warning and monitoring of canola disasters because of its advantages of macroscopic, rapid and wide-scale monitoring. The accurate monitoring data of *Brassica oleracea* L. has important guiding significance for the salvage work of *Brassica oleracea*. According to the remote sensing monitoring diagram and the coverage area statistical map of canola, the salvage work can be carried out in a targeted manner, and the mossy disaster can be understood and controlled in the shortest time. The development trend helps the management of canola.

Many scholars have carried out research on canola monitoring methods using satellite data such as EOS, FY-3, HJ-1A/1B, TM, SAR, etc., in the extraction of canola information, temporal and spatial distribution characteristics, hydrometeorological conditions of canola distribution, etc. Due to its cloud coverage and transit time, polar-orbit satellite data cannot meet the dynamic monitoring requirements of canola in terms of timeliness and dynamic tracking. At present, the more effective satellite remote sensing monitoring uses the canola monitoring method of the geospatial satellite Himawari-8 data to analyze the distribution range, variation, intensity, movement trajectory and velocity of the canola in the

Yellow Sea area in 2016, which can be a canola disaster. Provide reference for prevention, salvage and governance.

The geostationary satellite Himawari-8 (Himawari-8) was launched on October 7, 2014, with 16 channels: 3 visible channels, 3 near-infrared channels, 10 infrared channels, and spatial resolution of 0.5~2 km. 10 min can complete a full-disc map of the earth, featuring high spatial coverage and high temporal resolution, which is conducive to timely acquisition of canola information, Himawari-8 observation data, using its center wavelength of 0.64 μm, space Channel 3 data with a resolution of 0.5 km and channel 4 data with a center wavelength of 0.86 μm and a spatial resolution of 1 km monitor the canola information and resample the channel 4 data to 0.5 km, matching the channel 3 data.

The medium resolution spectro imager (MERSI) on the FY-3B meteorological satellite has five 250 m channels (Table 2): three visible channels, one near-infrared channel and one far-infrared channel, and channels 1 to 4 wavelengths. The range is basically the same as the wavelength range of the Himawari-8 channel 1~4. The multi-spectral camera equipped with the High Score One (GF-1) satellite includes four channels from the visible to the near-infrared range (Table 3) with a spatial resolution of 16 m and a wavelength distribution range of 1 to 4 for the Himawari-8 channel. Basically consistent. FY-3B and GF-1 data were used to test the results of the Himawari-8 canola monitoring. The above-mentioned remote sensing data were subjected to pre-processing such as radiation correction, geometric correction, projection conversion and cropping, and extraction of canola information.

The *Brassica* identification method is:

*Brassica* has a low reflectance in the visible light range and a high reflectance in the near-infrared region, which is very similar to the spectral curve of vegetation. The reflectivity of seawater in the blue-green band is relatively high, and the reflectance in the near-infrared band is almost zero. The spectral difference of canola is very obvious. Using red (R), near-infrared (NIR), and green (G) synthetic false color images, the moss-covered seawater often appears as emerald green patches, and the natural seawater is dark blue or black, making the distinction between canola and natural seawater very obvious. .

According to the spectral reflection characteristics of canola and seawater in the visible-near-infrared region, many scholars used single-band threshold segmentation method, dual-band ratio method, normalized vegetation index method, and planktonic algae index method to extract canola information.

The Himawari-8 visible light band (channel 3) and near-infrared band (channel 4) settings reflect canola, the band setting for Himawari-8, using the normalized vegetation index

(1)

$$I_{NDV} = (R_{NIR} - R_R)/(R_{NIR} + R_R)。$$

In formula (1), $R_{NIR}$ and $R_R$ are the reflectivity of near infrared band and visible red band respectively. The threshold method is used to extract the information of *Enteromorpha prolifera*, and the discriminant is as follows:

(2)

$$I_{NDV} > I_t。$$

In formula (2), $I_{NDV}$ represents the normalized vegetation index value of recognition pixels, and it represents the recognition threshold. To ensure the extraction accuracy of *Enteromorpha prolifera*, the threshold is determined by human-computer interaction. For the recognition region, when the $I_{NDV}$ is larger than the threshold, the pixel is considered as *Enteromorpha*.

The *Enteromorpha* intensity estimation method is:

*Brassica* strength refers to the degree of coverage of canola in the pixel, usually divided into no moss, mild canola, moderate canola and heavy canola, and the moss-free finger refers to the canola coverage of 0, the light degree of canopy coverage in the lens is 0,30%, the coverage of canola in the medium canopy refers to 30%, 60%, and the heavy canola refers to the canola cover in the pixel. The degree is ~~(~~60%, 100%~~)~~. The strength of canola has a certain indication of the degree and spatial distribution of canola.

The linear spectral mixture model is the most commonly used method in mixed pixel decomposition. In this model, the reflectivity of a pixel in a certain spectral band is determined by the reflectivity of the basic components constituting the pixel and the area of the pixel occupied by it. The ratio is a linear combination of weight coefficients. Considering the canola monitoring sea area, its components are mainly canola and seawater. According to the linear spectral mixture model $I_{NDV}$ can be expressed as:

(3)

$$I_{NDV} = I_V \times C + I_S \times (1 - C)。$$

In formula (3), $I_V$ is the canola normalized vegetation index, $I_S$ is the seawater normalized vegetation index, and C is the canola coverage.

(4)

$$C = \frac{I_{NDV} - I_S}{I_V - I_S} \times 100\%。$$

Among them, $I_V$ and $I_S$ use sample statistical method to determine, 1050240 (21 times) seawater effective normalized vegetation index data, select the largest 5% of the data to average, as $I_V$; select the minimum 5% of the data to average, as $I_S$. After calculation, $I_V$ uses 0.7 as the reference value, and $I_S$ uses -0.4 as the reference value.

The *Enteromorpha* velocity estimation method is:

Since the distribution range of canola is very wide, the moving speed of the center of gravity of the canola drift usually represents the moving speed of the canola. The calculation formula is:

(5)

$$V = \frac{S_1 - S_2}{t_2 - t_1}。$$

in equation (5), V is the moving speed of the canola, $S_1$ is the distance from the coast of the initial canola center (km), and $S_2$ is the distance from the coast of the canola center (km). $t_1$ is the initial time of the study, and $t_2$ is the end time; when the study duration ($t_2$-$t_1$) is set to 1 d, then V is the daily moving speed of the canola.

The use of satellite remote sensing technology can have a general understanding of green tide disasters such as canola, and it is necessary to closely monitor their proliferation, health and growth for large-scale canola green tides in the Yellow Sea. The maximum photon yield of algae can reflect the photosynthesis and growth of algae affected by external factors. Moreover, the chlorophyll fluorescence measurement of algae does not cause any damage to the algae, which is very fast and convenient. Therefore, in the canola monitoring, the health status of the floating algae body can be measured and evaluated according to the difference of the color and the maximum photon yield ($F_v/F_m$) corresponding to the algal body state. The method of photosynthetic physiological parameters immediately monitors and judges the health and growth vitality of the floating algae in the Yellow Sea, and screens, verifies and improves the health evaluation method of the green tide algae, and provides scientific reference and technical support for the monitoring and disposal of the green moss. The monitoring method is as follows:

collection of floating *Enteromorpha* samples of green tide algae;

observation of the color of *Enteromorpha*.

According to the color classification standard of floating *Enteromorpha* bodies, the parallel samples of each algae body collected at different stations were placed on white porcelain plates, and the colors were observed and classified.

method for the determination of chlorophyll fluorescence activity $F_v/F_m$ of *Enterophora*

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## Health Evaluation Level of Algae

In the general environment, the floating algae body will show certain differences in physiological state, and correspondingly, the chlorophyll content and $F_v/F_m$ are also different. Combined with the different colors of the floating algae, the $F_v/F_m$ was determined to construct a basic grade for evaluating the health of the algae. The algae were initially divided into four grades: Grade I; healthy algae, Grade II; sub-healthy algae, Grade III; semi-healthy algae, Grade IV;

senescent algae (Table below). According to the above classification, the sampled products were evaluated for the health of the floating green tide algae.

| Level | Color | $F_v/F_m$ |
|---|---|---|
| I | Green (G) | 0.7~0.75 |
| II | Green-Yellow (GY) | 0.60~0.69 |
| III | Yellow (Y) | 0.41~0.59 |
| IV | White (W) | 0~0.40 |

For plants, the most important biochemical reaction is photosynthesis, which can promote the reproduction and growth of plants, and reserve a steady stream of energy for plants. Therefore, it is speculated that the photosynthetic system of the green tide moss has changing environmental characteristics on the sea surface, has its own adaptability. The algae after collection will be stressed by diversification factors. If the sample is transported, its fluorescence parameters are measured in the laboratory, and the value and direct measurement will be significantly different. The method of collecting floating canola samples in the natural environment and measuring the photosynthetic physiological parameters of algae directly in the field using chlorophyll fluorescence technology can obtain more realistic and accurate data. According to the research data of the maximum photon yield of algae, it can be explained that algae photosynthesis and growth are affected by different environments. The method for determining the chlorophyll fluorescence of algae does not cause any adverse effects on the algae, and is fast and simple.

Studies have shown that the physiological state of the floating algae body in the natural environment is different, the algae body with higher health level has higher photosynthetic activity, and the $F_v/F_m$ value is correspondingly higher. Therefore, there is a lot of data that can be fully utilized. Through continuous research, we can promote the improvement and further development of the health evaluation system of the genus Brassica. It is clear that the photosynthesis characteristics of the floating green moss in the Yellow Sea have gained a dominant position in their growth competition. The role is to lay the foundation for the immediate monitoring and judgment of the health, growth and proliferation potential of the floating algae. Most studies at this stage show that, under normal circumstances, the $F_v/F_m$ of green algae is in the range of 0.70~0.75. The chlorophyll fluorescence activity ($F_v/F_m$) of the genus *Brassica* was used to monitor and judge the algal body state, health and growth vigor of the floating canola in combination with the color of the algae. This has important guiding significance for the layout of ship monitoring, judging the level of green tide warning and the organization of strength for cannabis salvage and prevention work.

The next step can be combined with the use of chlorophyll fluorescence parameters, chlorophyll content, relative growth rate and other indicators to comprehensively evaluate and predict the health status, biomass and proliferative potential of algae, and establish a more complete evaluation method for green moss, making green The assessment and prediction of tidal hazards is more accurate and scientific, which is critical for the potential assessment and scientific prediction of large-scale outbreaks of the yellow tide of the Yellow Sea.

## 3.2 Seawater Quality Monitoring

Numerous studies have shown that large green algae have a high specific surface area and exhibit a high nutrient absorption rate.

Green tides in the growing season require more nutrients, and the growth rate of algae is usually related to their ability to store nutrients, which relies on a sustained high level of nutrients to sustain outbreaks.

At present, the study shows that the southern part of the Yellow Sea area is a nutrient rich area. The nutrient supplied by the land source runoff input and the Yellow Sea warm current is greater than the consumption by phytoplankton. The rich nutrient salt ensures the growth of canola and other species in this area. It can be seen that sufficient nutrients are the material basis for the occurrence of green tides in the Yellow Sea. In addition, the formation and development of canola is related to many factors. In addition to its strong reproductive capacity and growth ability, suitable hydrological and meteorological environments such as temperature, pH, light intensity, salinity and wind field are important for canola outbreaks and migration. External factors promote the large occurrence of canola.

The adaptation range of canola to seawater temperature, pH value, salinity and light intensity is 10~30℃, 6~10, 16~40‰, more than 9 μmol/($m^2$·s) and the optimum range is 20~25℃, 8~9, 24~28‰, greater than 18 μmol/($m^2$·s), respectively. The moss drifted on the sea surface, and its drift path was affected by the sea surface wind field and ocean circulation. Quantitative analysis showed that the movement of the canola dense area was more consistent with the prevailing wind direction and drifted downward. In recent years, the occurrence frequency, impact scale and geographical range of canola have shown a clear upward trend. The hydrometeological conditions, the accumulation of canola and the direction of directional movement during the outbreak of canola should be the focus of monitoring and observation, with a view to prevention and control. Therefore, it is also necessary to monitor the water quality of the Yellow Sea, which is the basis for assessing the marine environment of the Yellow Sea and the early warning of the Yellow Sea ecological disaster.

The monitored items include: water temperature, salinity, pH, SS, DO, COD, inorganic nitrogen (nitrate nitrogen, nitrite nitrogen, ammonia nitrogen), active phosphate, petroleum, heavy metals (As, Hg, Cu, Pb~~)~~, Zn, Cd), chlorophyll a content, primary productivity, phytoplankton, zooplankton, benthic organisms, intertidal organisms, and biomass. The monitoring of phytoplankton requires clarification of its species composition and biomass per unit volume of seawater, and confirmation of phytoplankton richness index, diversity index and uniformity index.

For the canola outburst area in the Yellow Sea, the sea waters were collected at the surface, middle and bottom layer using a 30L Niskin water collector. Immediately after the water sample was collected, it was filtered through Whatman GF/F filter (burning at 450℃ for 4 h), and the dissolved inorganic nutrient was measured on site. The average value of the nutrient parameters, the surface average value, the surface layer concentration range, the middle layer average value, the bottom layer average value, and the bottom layer concentration range of each surveyed area were calculated.

The change of dissolved oxygen content in seawater is an important indicator reflecting the growth status of the organism and pollution status of the environment. The dissolved oxygen in seawater is generally derived from the dissolution of oxygen in the atmosphere and the photosynthesis of marine planktonic and benthic algae. For coastal waters, the distribution of dissolved oxygen is affected by biological activities, seawater movements and temperature. Runoff and rainfall also bring the oxygen-rich water. Distribution also has a greater impact. The distribution of nitrogen and phosphorus is one of the controlling factors for the growth and reproduction of marine plankton. At the same time, the composition of nutrients plays a crucial role in the growth of phytoplankton and changes in community structure. Adequate nutrient are the material basis for the occurrence of green tides.

According to the characteristics of the green tide outbreak, the monitoring parameters determined include temperature, salinity, DO (dissolved oxygen), Chl-a (chlorophyll a), $NO^{-3}$ -N (nitrate), $NO^{-2}$ -N (nitrite), $NH^{+4}$ -N (ammonia nitrogen) and $PO_3^{-4}$ -P (active phosphate).

Temperature and salinity were measured by CTD in situ; dissolved oxygen was determined by iodometry; nutrient and chlorophyll a water samples were filtered by 0.45 μm filter membrane, analyzed and determined in situ; ammonia nitrogen was determined by sodium hypochlorite oxidation method; nitrite was determined by naphthalene ethylenediamine spectrophotometry; nitrate was determined by zinc and cadmium reduction method (water samples were determined by cadmium). Nitrate was quantitatively reduced to nitrite by reduction column, and then the total amount of $NO^{-2}$ -N was determined by naphthalene ethylenediamine spectrophotometry, the content of $NO^{-3}$ -N was deducted from the original $NO^{-2}$ -N; the active phosphate was determined by phosphomolybdenum blue spectrophotometry; and chlorophyll a was determined by fluorescence spectrophotometry. The results show that the suitable conditions for the outbreak of green tide are: temperature 20-35℃, salinity 28-40‰. Dissolved oxygen, AOU in high value area was negatively correlated with Chl-a, dissolved oxygen supplement was higher than consumption, and the ratio of N to P was seriously imbalanced.

## 3.3 Regional Monitoring System

A comprehensive regional monitoring system will be developed to monitor and address nutrient changes (N/P/Si), climate change, jellyfish blooms and HAB in the Yellow Sea. This programme will involve application of ecosystem-based community management (EBCM) where risk management plans to address climate variability and coastal disasters will be developed. The project is supporting a series of activities leading to the development and application of EBCM by initiating regional monitoring, LWE-wide assessment and information exchange and consideration of the impact of climate change and coastal disasters at national and regional levels. Also, a regional assessment (including trends of introduced alien species) will be carried out so that policy-relevant recommendations can be made.

The Yellow Sea Large Marine Ecosystem is situated between northeastern China and the Korean Peninsula and has been significantly affected by human activities. More than 60 percent of its fish stocks are overexploited or collapsing.

The Yellow Sea Large Marine Ecosystem Project (YSLMEP) is a transboundary initiative providing advice and assistance to China and South Korea to implement ecosystem-based, environmentally-sustainable management of the Yellow Sea and its watershed.

The initiative is led by the United Nations Development Programme, with $15 million of funding from the Global Environment Facility (GEF), a fund managed by the World Bank. China and South Korea have pledged $9 million in co-financing.

The initiative was sparked through meetings sponsored by the World Bank and the U.S. National Oceanic and Atmospheric Administration in 1992. A Transboundary Diagnostic Analysis identified management deficiencies and shared environmental problems and a Strategic Action Programme (SAP) recommended a series of management, legal, policy and institutional reforms and outcomes that could be accomplished by 2020.

In 2009, China and South Korea committed themselves to the reforms by signing a statement of mutual agreement to implement the SAP. Additionally, the YSLMEP has signed a memorandum of understanding with the World Wildlife Fund and its collaborators to conduct pilot projects with stakeholders at several locations to demonstrate effective management.

To facilitate communication, cooperation and implement joint activities among various environmental initiatives in the region, the YSLMEP developed the Yellow Sea Partnership, which includes local, national and international government and private organizations.

The mission of the Yellow Sea Large Marine Ecosystem Project is to assist the three national stakeholders in the region - China, South Korea and North Korea - realize environmentally-sustainable management and use of the Yellow Sea and its watershed, thereby reducing development stress, and promoting sustainable exploitation of the ecosystem from a densely populated, heavily urbanized and industrialized semi-enclosed shelf sea.

**Objectives**

The Strategic Action Programme is aimed at improving the ecosystem carrying capacity and lists the following 11 regional management targets to achieve by 2020:

- Reduce fishing effort by 25 to 30 percent
- Rebuild over-exploited fish stocks
- Improve aquaculture techniques
- Meet international contaminant requirements
- Reduce nutrient loading
- Reduce marine litter
- Reduce contamination of beaches
- Improve prediction of ecosystem changes
- Improve biodiversity status
- Maintain habitats
- Reduce risk from introduced species

The Yellow Sea is a semi-enclosed sea between northeastern China and the Korean Peninsula. The sea floor is one of the largest shallow areas of continental shelf in the world. More than 1.6 billion tons of sediments flow into the Yellow Sea each year from the Yellow and Yangtze Rivers. Surface water temperatures and salinity can fluctuate.

Although it is shallow, the Yellow Sea historically has been rich in fisheries resources. More than 270 species of fish are found in the Yellow Sea. In 2004, 2.5 million tons of fish were landed, while 400,000 tons in 1986.

## Threats

Overfishing and unsustainable mariculture are two key stressors on the ecosystem. The fishery has changed dramatically in 30 years. High-quality bottom fish species have been replaced by lower-value, smaller pelagic species. Aquaculture and mariculture has increased dramatically. China and South Korea account for 70 percent of the total world production.

Population pressures and poor development practices have reduced the ability of the Yellow Sea to respond to those stressors. About 600 million people live in the area that drains into the Yellow Sea. Over abundant amounts of nitrogen and phosphate, sewage, heavy metals, persistent organic pollutants and marine litter are polluting the Yellow Sea. According to the World Wildlife Fund, more than 40 percent of the coastal wetlands have been lost through conversion into ~~to~~ other uses ~~through development~~, such as agriculture, residences and industry.

Along with the alteration in the fishery, increases in harmful algae blooms and jellyfish populations, which further hurt fish stocks by consuming additional amounts of fish larvae, are additional indicators of the stress on the ecosystem. Climate change will further exacerbate the stress on the ecosystem.

The Strategic Action Programme for the Yellow Sea Large Marine Ecosystem Project recommends a host of technical and governmental actions to achieve the 11 regional management targets. In broad terms, the actions use a variety of strategies, including:

- Assisting national stakeholders and the public, through workshops, conferences, and public educational efforts, including school programs and targeted messages to industry, to understand the environmental concerns and the need to address them.
- Building capacity of institutions through several means, including the use of training sessions and workshops.

- Identifying institutional gaps and recommending development of new legal, policy and enforcement measures.
- Improving national and regional cooperation between government agencies.
- Eliminating environmentally damaging subsidies.
- Implementing regional monitoring networks.
- 

Examples of specific management and governmental actions recommended for national implementation include:

- Establish training programs for fishermen to seek alternative employment and offering tax incentives.
- Establish total nutrient control programs in development plans.
- Increase funding opportunities for recycling programs.
- Establish Marine Protected Area networks.
- Improve compliance with waste management laws.

The Strategic Action Programme recommends a host of new monitoring initiatives to develop information on biological characteristics in the Yellow Sea to increase understanding and evaluate management actions.

Day-to-day evaluation of the project is conducted by the Project Management Office and the Project Steering Committee. Periodic evaluation were established at the outset of the project, including a Project Implementation Review, Mid-Term Evaluation and Final Evaluation (MTE).

The MTE, conducted by outside experts, was the most recent benchmark evaluation. It identified strengths and weaknesses of the project design, and rated the progress of the project on 11 criteria, including country ownership of the project, stakeholder participation and implementation approach. In reviewing the history of the project, the MTE presented lessons that could be used by future projects. For instance, the MTE described the three-year lag in project implementation due to a disagreement between China and South Korea on logistical matters, including the site of the project office. The MTE suggested developing face-saving mechanisms to resolve similar disputes, such as rotating the project office between countries.

# 4 Capacity Development Program

## 4.1 Development of Ocean Observing Capability

Human scientific understanding of the ocean relies on a variety of observations and detection methods. The development of modern marine science is the epitome of the continuous development of ocean observation technology with the use of marine research vessels and shipborne equipment to achieve coverage of limited time and space in the ocean; in order to obtain large-scale, long-term, continuous observation data, establish and improve an integrated three-dimensional automatic observation and monitoring system consisting of various types of snorkeling targets and satellites and aerial remote sensing; launch a series of international observations and scientific research for in-depth exploration and comprehensive mastery of global ocean information plan.

The international advanced regional real-time monitoring system forms a complete chain through "real-time observation-mode simulation-data assimilation-business application" and provides information services for scientific research, economic and military applications through the internet. The observing system consists of a number of platforms with reasonable spatial layout, such as coastal hydrology/meteorological stations, marine buoys, submarine standards, seabed bases and remote sensing satellites. It uses a variety of advanced sensors and observation instruments to make points and lines. The combination of surface and surface is more closely, real-time effective observation and monitoring of the marine environment, intensified observation of important phenomena and process mechanisms, and long-term data accumulation, serving scientific research and practical applications.

The marine scientific research in the Yellow Sea requires continuous and long-term observational data. The marine automatic observation system can realize these functions, including the marine stereoscopic observation system composed of ocean buoys, underwater mobile observation platforms and marine satellites.

**Marine buoys**

The ocean buoy has the ability to collect marine environmental data in a stable and reliable manner around the clock. It can realize automatic data collection, automatic labeling and automatic transmission, with low cost and no environmental impact. At present, the international development trend is to deploy a buoy network or a buoy array to achieve high-resolution ocean observations on large areas of the sea. In 2009, China completed the construction of China's offshore ocean observation research network system, in which a certain number of buoys were arranged in the Yellow Sea. The buoy system can share a total of nine data set parameters: wind speed, wind direction, air pressure, temperature, water temperature, conductivity, salinity, chlorophyll, turbidity and so on.

**Underwater mobile observation platform**

Submarine observation and research using underwater mobile observing platforms are essential. The underwater mobile observation platform mainly includes a cable for remotely operated vehicle (ROV), a cableless underwater robot (AUV), and an underwater self-propelled ocean observation platform (AUG). ROVs can dive to work in deep or hazardous environments that are unreachable by researchers. China's newly built Xiangyanghong 01, Dongfanghong 02 and other scientific research vessels are equipped with ROV, AUV and AUG, which can investigate and detect in ecologically sensitive areas.

## Marine satellites

Satellite remote sensing has a wide coverage, strong synchronism and timely data supply, which can greatly improve the capability of ocean forecasting and resource detection. After half a century of development, satellite remote sensing observation and detection has made great achievements, from visible light detection to synthetic aperture radar, the channel is expanding; from single product to multi-product comparison and assimilation; from the observation of ocean elements to power, and even observations of geochemistry and climate change. China's Environmental No.1 satellite can be used for the monitoring of the Yellow Sea marine environment. The MODIS numerical model based on the satellite has been established by Chinese scientists for the assessment of the Yellow Sea green tide.

Marine science is increasingly focusing on the development of comprehensive research on major programmes, including many regional and global major initiatives that have been indispensable for the establishment of the International Ocean Observing System. Every international research project has clear scientific goals and scientific problems to be solved. The research plan is to solve key scientific problems, including research ideas, observation programs, research and development of instruments and equipment, etc., all of which are based on how to achieve scientific goals. The YSLME project allows more scientists involved in other major marine research projects in order to improve the YSLME technology level and serve the better protection and improvement of the Yellow Sea marine environment.

Ocean observations have been dominated by marine elements and ocean circulation observations in the past, and have developed to the stage of equal emphasis on ocean circulation, ocean geochemical cycle and marine ecological observation. Marine scientific research is developing in depth, from the description of the average state of the ocean to the study of the process of ocean change, from the qualitative description of the phenomenon to the quantitative and accurate forecast. Facing the future, the development of marine science and the resolution of major marine science issues depend more on the acquisition of ocean data in stereo, continuous, real-time and long-term. The marine monitoring of the Yellow Sea should be strengthened in the following aspects:

- Emphasis on holistic and systematic observational principles, presenting the development trend from single subject observation to multidisciplinary integrated cross-integration. The observation of geochemical cycle and marine ecology is receiving more and more attention, and optical ecological observation and carbon water flux observation are urgently needed. It is added to some YSLME project activities being implemented, and at the same time, the development of project activities must be characterized by scientific and comprehensive intersection.

- The observation of the Yellow Sea from the ground-based and ship-based observations to the combination of sea-based, aerial-based observations is rapidly developing in the direction of digitization and networking, and gradually develops into a stereoscopic observation network covering the entire Yellow Sea region and key areas.
- Research on marine science in the Yellow Sea is increasingly dependent on long-term continuous observation, detection, and accumulation and analysis of experimental data. Large-scale long-term observation, monitoring, and information networks throughout the Yellow Sea region need to be formed.
- The more social demand orientation is strengthened, the service and economic development goals will be more prominent.

Strengthen research on monitoring technologies such as catastrophic marine events (such as canola) and participate in addressing global climate change.

While clarifying our capacity building, we still face the following challenges:

- The demand for high technology is urgent. Ocean observation is dependent on the development of high-tech marine technology. Every innovation in high-tech will bring revolution to ocean observation. With the frequent occurrence of disasters such as green tides, new challenges have been raised for high technology.
- Long-term continuous huge capital investment cannot be ignored. The YSLME has been implemented in two consecutive phases, but the total amount of funds for the project seems to be a drop in the target for us to achieve, and there is an urgent need for sustained large-scale investment in the countries surrounding the Yellow Sea to support our goal.
- Data sharing issues are common. Despite some progress in data sharing, it still faces huge problems. Many observing systems

are owned by several departments or countries. Each observing system has its own independent data management system, data format, data standards and transmission methods, resulting in the inability to share data between different systems and waste resources. At the same time, different scientific research and application requirements have different requirements on data quality and form. For example, the forecasting department pays attention to the real-time data, and the research department pays attention to the resolution and accuracy of the data. Differences in demand also affect the choice of sensors and communication methods and data processing methods, resulting in data sharing between different systems.

## 4.2 Development of Regional Management Capacity

Regional ocean management is based on ecosystem management and ocean integration, and aims to protect countries' deteriorating environment and promote the sustainable use and development of marine resources and the environment. Foreign scholars focus on regional management research on the definition of related concepts and the roles and capabilities of government regional marine management. The large marine ecosystem (LME) proposed by an American scholar, Sherman is a method for dividing regional ecosystem management according to the ecosystem that has been successfully applied in practice, and has been recognized by many countries.

In the international practice of regional marine management, there have been many successful practices in regional marine management. On the Baltic coast of the western Europe, the six Baltic countries have unanimously adopted the Helsinki Convention on the Protection of the Baltic Sea Environment, aimed at reducing, preventing and eliminating pollution, and established a specific implementing agency, the Baltic Commission, which introduced the precautionary principle and the burden of polluters. The principle of gradually improving the marine ecosystem within the region. In 1988, the US Environmental Protection Agency began implementing a community-based Gulf of Mexico program to address the marine environment facing the Gulf of Mexico, emphasizing the federal and Gulf states government and NGOs to participate in the protection and restoration of the Gulf coast and ocean waters. Since this plan adopted a method of establishing a centralized management group to solve the environmental protection problem in the Gulf of Mexico, it has achieved good governance effects in the region.

The Yellow Sea Large Marine Ecosystem Project was born under this management trend and has now come to the end of the second phase of the project. The so-called local government capacity in the marine management of the Yellow Sea region, that is, in the process of regional ocean management, each coastal local government fully mobilizes various marine resources and fulfills its own marine management functions on the basis of rational and effective use of public power. The total capacity of the regional marine ecological environment and the sustainable development of the regional marine economy. In the process of regional ocean management, local government capacity is a system that is a combination of several capabilities.

In this capacity system process, it includes ocean policy capabilities, marine talent management capabilities, marine public crisis management capabilities and marine resource integration capabilities. The coordination and integration ability of local governments, as a main line of ability, runs through the various capabilities, thus jointly forming an organic regional capacity management system in regional ocean management. Strengthening the capacity building of local governments along the Yellow Sea should emphasize what the local government should “do”, rather than “what to do”. The prominent point is that local governments should improve their regional marine ecological environment by promoting their specific capabilities for sustainable development of the ocean.

From a geographical perspective, regional ocean management is a comprehensive management of “cross-border areas”. The so-called "cross-border area" refers to a special space range formed by crossing the boundary of the upper or lower administrative divisions of two or more regions that are adjacent to each other and have no affiliation. The cross-border area does not belong to the administrative scope of any administrative region. It is the control area of multiple political powers, and various conflicts and contradictions are complicated. It is indispensable and difficult for local governments to communicate, coordinate and integrate with each other in a “cross-border area”. Therefore, in the regional marine management, the coordination and cooperation between local governments has put forward higher requirements for coordination ability among countries.

National and local governments along the Yellow Sea should strengthen capacity building in the areas of strengthening local government capacity, enhancing local government capacity to negotiate coastal and ocean issues with business, academia, resource user groups and the general public, and strengthening coordination of sectoral programmes. Capacity, strengthen the capacity of human resources development and scientific and technological infrastructure construction, strengthen the research and development capabilities of marine science and technology, strengthen the ability to promote and assist the development and education of human resources, support the cultivation of talents in the comprehensive management of marine resources, and increase the financial support for pilot demonstration programmes and projects in integrated marine management.

In the field of marine environmental protection, it is necessary to strengthen the review and control of all land activities and pollution sources, develop research facilities for systematic detection of marine pollution and environmental impacts, strengthen financial and technical support for solving problems in the marine environment for developing countries, and establish a target for the Yellow Sea. The four aspects of coastal water treatment technologies and facilities' international funding mechanisms protect the marine environment.

Local governments should focus on and improve their learning ability, ability to coordinate and cooperate with other organizations, and strengthen marine information processing capabilities. Integration, coordination and cooperation factors are indispensable for building a scientific capacity system in sustainable development, and are the most important factors for local governments to deal with ocean management and coastal zone management in the Yellow Sea. Strengthening the ability to cooperate, learn and adapt to knowledge is very important in government capacity building.

The government itself does not completely prevent the misuse of marine and coastal resources. Private and public sector partnerships are essential in improving local government management of regional marine management capabilities. Local governments along the Yellow Sea coast should strengthen the following capabilities: the required information capabilities, the ability to enhance user engagement in collaborative networks, the ability to ensure the integrity of information systems, the ability to solve technical dilemmas, the use of information and communication technology capabilities, and the ability to verify quality assurance and provide support for implementation and development.

Regional marine management is a multi-agent with core government as the core of the Yellow Sea, and coordinates various sea-related behavior management activities among various stakeholders in the region. Based on the ecosystem, the management boundary is defined by the ecosystem, the goal is driven and the cooperation and coordination are emphasized.

As a management method that is different from the traditional ocean management in pursuit of economic benefits and purposes, regional marine management must use the ecosystem as the standard for regional division and manage the marine area according to the integrity of the ecosystem. Ecosystem-based standards are the primary consideration, but at the same time, the formulation and implementation of regional ocean management policies must also take into account the actual and regional specific characteristics of social life. Local government as a direct implementer of regional marine management, its ability is good or bad, its ability to directly affect the effectiveness and quality of the implementation process.

The stronger the local government's own capabilities, the better it will play its overall leadership and overall planning role in regional ocean management. In response to regional ocean management, the local government is looking for ways to improve local government capacity in marine management in the Yellow Sea region in terms of ocean affairs coordination capabilities, resource integration capabilities, policy capabilities, crisis management capabilities, and talent management capabilities.

(1) Strengthening the construction of a learning-oriented government and strengthening the knowledge renewal and capacity awareness of local governments

It refers to the formation of a strong learning atmosphere within the government, the improvement of lifelong education system and mechanism, and the formation of a good atmosphere for full staff learning, team learning and organizational learning, so as to improve the group ability of the whole local government. It is very important to strengthen the construction of learning government and strengthen the systematic study and training of the theoretical knowledge related to regional marine management. The YSLME should provide a good platform for local government training.

(2) Rationally transform government functions and clarify the functional orientation of local governments in regional marine management

At present, our government is transforming from a management-oriented government to a service-oriented government, so that the fulfillment of its various functions can provide more and better public services to the people, rather than just for its own performance indicators.

Similarly, in the implementation of regional marine management, local governments have put in many efforts and practices in undertaking regional marine economic regulation functions and fully tapping the potential of marine economy, and promoted the development of regional marine economy. However, regional marine management is an integrated marine-based management of the ecosystem, emphasizing the achievement of comprehensive, coordinated and sustainable development of the regional oceans. This requires local governments to fully transform their functional orientation in the process of regional marine management. They should not only pay attention to traditional economic development functions, but should also emphasize the full implementation of functions such as marine environmental protection, marine public welfare services and marine cultural construction. Make local governments play a more effective role in regional marine management.

Regional marine management should be integrated with ecosystem-based management. Therefore, relevant local governments must place environmental protection functions in an important position when carrying out various activities, and should not seriously develop and destroy the marine environment. Relevant local governments should organize the YSLME projects, provide the necessary implementation channels, hire relevant marine expert groups to engage in marine data collection and marine environmental research, provide effective consulting services for marine development enterprises or individuals, and assist them in solving management in marine development activities or technical problems. On the basis of full understanding and understanding of the characteristics of the regional oceans, local governments should popularize marine knowledge to coastal residents through various means, improve people's scientific understanding of the ocean, and enable people to fully understand the human and ocean in the process of ocean development. Relationships, the relationship between marine development and utilization, environmental protection, and the relationship between regional marine management and integrated marine management have improved the marine cultural knowledge of the coastal people.

(3) Start from the perspective of strengthening various capabilities and gradually build a perfect local government capacity system.

In the construction of this capacity system, the coordination capacity of local governments should be integrated into each capacity, and the regional marine management capacity of local governments should be improved by focusing on coordination and integration in each capacity construction.

When formulating regional marine policies, local governments should fully learn the advanced experience of marine management outside the Great Yellow Sea, attach importance to improving the long-term planning capabilities of regional marine ecosystems, and pay attention to the maintenance of regional marine ecosystems. System management is a source of motivation for the formulation of ocean policy. Establish an information database of marine talents in the region as soon as possible, and regularly exchange information on talent data between regions, and then have a macro level of mastery of marine talents in the region as a whole, and also facilitate the guidance of the flow of marine talents between regions. Enhance local government's ability to manage marine talent in the region. Make full use of marine social resources, give full play to the social attributes of marine resources, and use abundant marine resources to provide coastal people with more income sources, employment opportunities and life guarantees, ensure the public attributes of regional marine management, and promote the fullness of various marine resources. On the basis of utilization and integration, the development results will be shared by all people.

From the height of the law, the attention issues, handling procedures, and related responsibilities in the management of marine crisis are determined to ensure that government departments have laws to follow when dealing with marine crisis management, law enforcement must be strict, and violations must be investigated. In the face of marine disasters such as green tides, we can respond to and respond to disaster situations in the first time under unified guidance and effective communication and coordination, and comprehensively arrange and deal with the losses caused by disasters. The marine crisis management capabilities of local governments in the region ensure the effective implementation of the overall integrated management of regional marine management.

(4) Strengthening the construction of regional marine laws and regulations to provide legal protection for local government capabilities

In the implementation process of regional marine management, only by continuously improving the relevant laws and regulations in the implementation of regional marine management, only by continuously improving various relevant laws and regulations can we provide legal guarantee for local governments to strengthen capacity building. Under the guidance of a sound and complete regional marine law and regulation, local governments along the Yellow Sea can only rely on laws and regulations to improve their ability to handle ocean affairs when they encounter various problems.

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