East China Sea

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1. Introduction

East China Sea of the western Pacific Ocean is geographically surrounded by a number of countries, mainly including China, South Korea (Cheju Island) and Japan (Figure 1). The total area of East China Sea is ca. 770,000 km^2. Most sea area has water depth >200 m, except Okinawa Trough where the water depth deepens to >1000 m (>2000 m in maxi.). Average salinity of seawater ranges between 32-34‰, and the average seawater temperature is 9.2℃, but >20.0℃ in winter in the southern part of the East China Sea. Precipitation is seasonally concentrated in May – September every year. Beside, freshwater feeding East China Sea is mainly from the Changjiang River basin, China, which supplies a huge amount of freshwater (annually ca. 924 x 10^9 m^3), in addition to many relative small-scale river streams in the eastern coast of China, and the surrounding counties. It is apparent that terrestrial nutrients carried by the freshwaters into East China Sea have long kept the ecological balance of the region, thus to have nourished the growth of fishery production, which is, in turn to have substantially supported the healthy development of our human society. It is however, that we have seen in recent decades severe environmental degradation in East China Sea, mainly over-nutrient-triggered seawater eutrophication, and rerated occurrences of red tides and low oxygen, via bio-geo-hydrological processes. This has declined greatly the water quality, and fishery quality and quantity has been largely undermined. This is primarily caused by the rapid growth of population in surrounding countries, especially on the eastern part of Chinese coast, where hundreds of millions of people have lived there engaging in agricultural, fishery and industrial activities. In the past decades, intensifying human activities in the southwestern Japan coast also sees increasing impact on the environmental conservation of the East China Sea (Zhang, et al., 2019), and coastal land reclamation to release population pressure has made no ecological buffering zone between the land and sea. Also, pollutants possibly driven into East China Sea via sea currents from the northern Yellow Sea (Zhang et al., 2019).

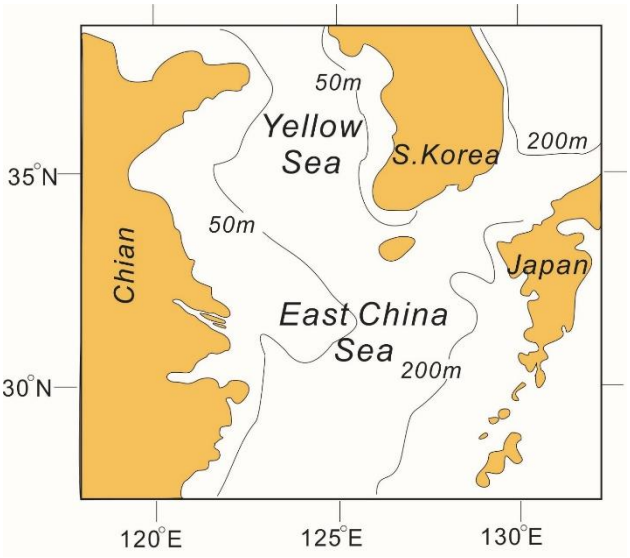

Figure 1 Geographic location of East China Sea

2. Environmental challenges

(1) Sources of Pollutants

The water quality degradation of East China Sea is mainly caused by over pollutants from terrestrial sources. Sources of water pollution of the sea are mainly derived from industrial and agricultural activities, and human sewages via urbanization in the river-basin and coast in the surrounding countries. Literature search has shown that pollutants from the Changjiang River basin, China are the major source of pollutants into East China Sea (Figure 2) via discharge and coastal/estuarine water currents. For instance, dissolved inorganic nitrogen (DIN) carried by the Changjiang River water has increased from 0.4 mg/l in 1950's to 1.7 mg/l in 2000's (Xu et al., 2014), 4.2 folds more than that of decades ago. This is apparently due to the overuse of nitrogen fertilizers in the river-basin (Figure 2), which matches the social requirements from rapid increasing population to >400 million. Also, basin-wide urbanization causes tremendous increase in domestic sewerage discharge to East China Sea, via the flow passage of river-estuary. In present, domestic sewerage has become the primary contributor of source pollutants comparing other sources (Xu et al., 2013). As said, pollutants transported from North Korea and Japan coasts into East China Sea through ocean currents are also potential issues to be called for attention (Zhang et al., 2019).

(2) Degraded water quality

The recent investigation showed higher concentrations of Nutrient, i.e. (NO3(-)-N, PO4(3-)-P, Sio3(2-)-Si, NH4(+)-N, occurring in the coastal waters in the Changjiang River coast-estuary. The concentrations of dissolved inorganic nitrogen (DIN) and PO4(-)-P reached 46% and 60% (Li et al., 2004). This has inevitably led to eutrophication and the red-tide occurrence. Increasing tendency of Hypoxia (Oxygen <2 mg/l) zone in/off the coastal waters of East China Sea is an urgent alert to human health via food-chain system (Zhu et al., 2017). Lower DO concentrations (<2–3 mg/l) covered a large East China Sea was also reportedly in recent years (Chen et al., 2007).

Over-nutrients cause development of eutrophication of the coastal waters and the estuarine area, which stimulates quite often the occurrence of red tides. The environmental pollution of the Changjiang River basin has directly exerted a huge negative impact on the state of the marine environment in the East China Sea. A sound circulation of ecosystem of the East China Sea is maintained by a steady water discharge from the river, that mixes with the marine salty water in the estuary, and the sediment loads from the river that balance ocean erosion in the delta and its adjacent coastal area. However, dam construction and the large-scale water transfer projects in the

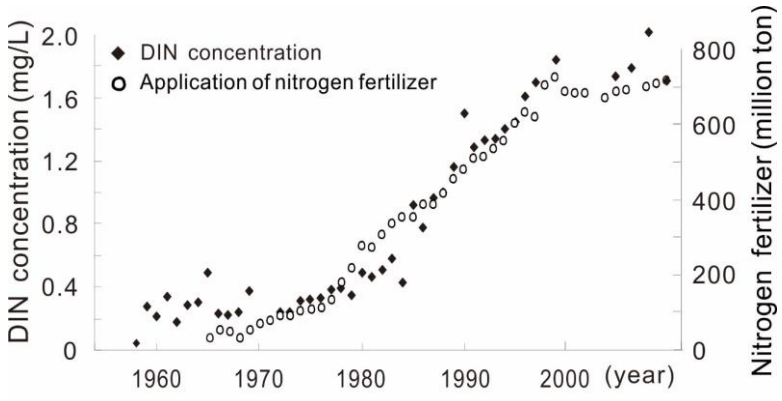

Figure 2. Mean annual concentrations of DIN at Datong gauging station of the lower Changjiang River basin (modified after Xu et al., 2013), and annual nitrogen fertilizer application in the Changjiang River basin (data source: http://www.stats.gov.cn/tjsj/ndsj/);

Changjiang River basin have significantly altered the ecological balance. Discharge into the sea has been seasonally changed, >70% sediment load has been cut off, and the ratio of nutrients (P:N:Si) in/off the Changjiang River estuarine waters has also been largely altered (Li et al., 2007).

(3) Pollution-related decline of fisheries

It is of noted that although climate change and other factors may affect the fish catches in the East China Sea, land-based pollution of the region plays a significant role in such decline. Chang et al. (2012) reported that the diversity index of demersal fish showed significantly negative correlations with nutrient concentrations and positive correlations with bottom-water dissolved oxygen in the China's inshore area of East China Sea, where is seasonal prohibited trawling zone, and has extremely high nutrient concentrations and relatively low dissolved oxygen. In contrast, the offshore areas, with lower nutrient concentrations and higher dissolved oxygen, had higher biodiversity. These findings suggest that eutrophication is responsible for the limited recovery of fishery resources in the trawling prohibition area of East China Sea.

(4) Over fish catches

East China Sea is one of the largest fish catches in the world, producing large and small yellow croaker, Coilia ectene, and cuttlefish etc. it was reported that fish catch in the time of 1950-2014 in East China Sea was 288.28 Mt, 4.44 MT/year, 6.71 MT in the year of 2014, 6.84 MT in the peak year of 2013 (Sumaila, 2019). This corresponds to the value of 410.12 US dollars 6.31 US dollars 9.86 US dollars and 13.96 US dollars, respectively. Also reported is that catch per unit effort drops ~4 times more than few decades ago (Sumaila, 2019). Obviously, the increasing fish catches in the region is certainly due to the pressures from human livelihood, but from other hand, the over catch is closely associated with the poor marine governance and policy decision and management. There were problems of illegal, unreported and unregulated fisheries. The proportion of unreported to reported catches of up to 50% in the case of the SCS (Sumaila, 2019).

3. "Multi-national Integrated Management of East China Sea" is to be urgently established

What insufficiencies in challenging against environmental issues above-mentioned is the lack of effectively international cooperation of management in the East China Sea. This has resulted in the poor governance and policy making and implement among relevant countries. The main challenge for solving issues is to integrate socioeconomic and environmental decision making in order to promote sustainable development. There is so far no multi-national organization established, which can cope effectively each other with any environmental issues in East China Sea under the Integrated Marine Management policy by United Nation. International cooperation should be an important contributor to the progress and in particular provide access to financial, technological, scientific and human resource assistance.

China, Japan and South Korea would have been expected to have an "Integrated Commission of East China Sea Management". Therefore, a better understanding of the driving forces in society that causes the environmental pressures is required to overcome such obstacles. This would enhance better understanding mutually of transboundary challenges of environmental degradation, through effective ecosystem-based governance approaches. Regular meetings/workshops can be organized under such commission to share each other high-tec-based observation, dataset, and policy

modification/ implementation. This inter-governmental collaboration will also bring our societies together to an unprecedented future in the regards of alleviating increasing pressures from human development, while progressing towards efficient management of East China Sea (cf. Zhang et al., 2018).

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