中国沿海地区生态环境现状与保护

ECOLOGICAL SITUATION AND PROTECTION OF CHINA'S COASTAL AREAS

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摘要

近几十年来，随着沿海地区人类活动（例如城镇化、围垦、人工养殖、固滩、石油开采等）强度的逐渐增加，中国海岸带的自然岸线在逐年减少，人工海岸比例已超过40%。这种人工化的高强度开发对海岸带自然景观和生态环境造成了强烈干扰。该访谈介绍了目前中国海岸带生态环境的整体状况，以及近年来几大三角洲自然景观和生态环境的转变，强调了沿海地区应在经济发展与环境保护之间寻求平衡，并应针对全球气候变暖、海平面上升等问题，展开全国尺度的海岸带生态监测与评估。

关键词

海岸带；中国；三角洲；围垦；生态保护

ABSTRACT

As coastal urbanization, reclamation, aquaculture, shoal-reinforcement, and oil exploitation have intensified over the past few decades, China's natural coastline has shrunk. The man-made coastline now accounts for more than 40% of the total national coastline. Such intensive development has disturbed the natural landscape and ecosystem of the coastal zones. This interview introduces the overall ecological situation of China's coastal areas including changes in the major delta areas of China. It stresses that development of coastal areas should be coordinated to best balance economic growth and ecological protection. It encourages the establishment of a nation-wide ecological monitoring and assessment mechanism that will help respond to pressing issues including climate change and sea level rise.

KEY WORDS

Coastal Zone; China; Delta; Reclamation; Ecological Protection

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能否请您简要介绍一下中国沿海地区的基本状况？这些地区的景观面貌在近些年来发生了哪些重大改变？

李国胜（以下简称李）：中国大陆地区的自然海岸类型主要包括基岩海岸、砂质海岸、淤泥质海岸和生物海岸等。基岩海岸主要分布在东南沿海（浙江、福建、广东等地）、山东半岛和辽东半岛等地；砂质海岸以环渤海及南方沿海地带居多，如秦皇岛、北戴河、广西、海南等滨海旅游城市的周边地区；而淤泥质海岸则主要分布在长江三角洲至苏北、黄河三角洲至渤海湾西岸地区，以及珠江三角洲、辽河三角洲和滦河三角洲等区域。其中，苏北地区是全球最大、最典型的淤泥质海岸分布区之一，具有极高的研究价值。

近几十年来，随着沿海地区人类活动（例如城镇化、围垦、人工养殖、固滩、石油开采等）强度的逐渐增加，中国海岸带的自然岸线在逐年减少。目前，从辽宁省大连市起一直到江苏省南通市，除了辽河三角洲自然保护区的部分岸段外，G206、G228和G328等临海高速公路几乎占据了中国海岸线的一半里程。在锦州段，高速路几乎紧贴海岸线而建，部分地区甚至直接在淤泥海岸上灌注混凝土建设道路。最近，广东省正筹备在珠江三角地区乃至全省沿海地区建设一条滨海高速路。这种高强度的人工开发无疑是对海岸带自然景观和生态环境的一种强烈干扰。

目前，中国人工海岸比例已超过40%，仅低于荷兰等欧洲北海沿岸地区以及少数太平洋岛屿国家。在荷兰等低地地区，人工海岸建设是为保障生存环境而不得已采取的措施。中国的情况并非如此，人工海岸比例逐步提高的主要原因在于经济建设对后备土地资源的迫切需求。作为中国经济最发达的区域，沿海地区的国内生产总值占全国国内生产总值的60%以上，全国70%以上的大城市都聚集在沿海地区，同时也吸纳了全国40%以上的人口。有限的土地资源显然已经无法满足社会经济不断增长的需求，只能“向海洋要土地”——对沿海滩涂进行围垦，用以建设交通基础设施、港口码头、城市新区等，创造出了一处处人工海岸景观。

您对中国几大主要三角洲（长江三角洲、黄河三角洲、珠江三角洲、辽河三角洲等）地区进行过多年的研究，能否请您介绍一下这几大三角洲目前的状况？

李：在这几个主要的三角洲中，辽河三角洲和黄河三角洲的自然景观和生态环境的

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1. 辽河三角洲河口的自然滩涂景观

1. Natural muddy coasts in the estuary of Liao River Delta

保存情况相对完好。一方面是由于这些地区城镇化进程及经济发展速度相对缓慢，另一方面是由于这两个三角洲地区都设有国家级自然保护区，对海岸带自然景观和生态环境的保护起到了重要作用。但近些年来，辽河三角洲地区开始出现一些明显的变化：在辽河三角洲河口的几个主要苇场区域，为了便于石油开采，油井不断向滨海区域延伸，沿海芦苇湿地上不断浇灌出一条条水泥硬化路面用于运送物资。这些开发建设活动已对当地的生态环境造成了干扰。

相较而言，长江三角洲和珠江三角洲地区经济发达、城镇化程度高，人工干预程度也更大。值得指出的是，虽然珠江三角洲的地区经济发达程度也很高，特别是“粤港澳大湾区”建成后将成为中国沿海地区的重要经济增长极，但从目前来看，珠江三角洲地区生态环境受到的干扰程度却相对较轻。这很大程度上得益于珠江三角洲地带拥有悠久的“桑基鱼塘”历史，形成了一种桑叶养蚕、废水养鱼、鱼粪肥桑的能量流系统，促进了三角洲地区生态的良性循环。如今，虽然大量的桑基鱼塘已经消失，但这一生态工程的理念和成功经验在珠江三角洲湿地生态保护和修复中得到了传承。加之珠江三角洲“八大口门”之外的沿海地区大多受丘陵地貌限制，城镇化及经济发达程度相对偏弱，客观上也使得沿海自然景观和生态环境得到了相对较好的保护。情况最不容乐观的是长江三角洲地区，高歌猛进的经济发展和城镇化过程使得那里的自然景观和生态系统在过去几十年间发生了很大程度的改变，甚至造成了不可逆转的退化。

您认为沿海地区应如何在社会经济发展与生态保护之间求得平衡？

李：中国对海岸带的人工利用过程从唐宋时期就开始了。宋朝时，为了保护江苏中部地区免受潮水侵害，范仲淹主持建造了一座全长大约300km的堤坝，后被命名为“范公堤”。但这座堤坝工程几乎完全由泥土堆砌而成，并未彻底阻断海岸带自然湿地系统的水文交换过程，这种改造对海岸带自然生态系统的影响并不十分显著。而如今由钢筋和混凝土筑造的人工海岸，已经完全破坏了自然生态系统的景观面貌以及海洋与陆地间的物质与能量交换，打破了自然生态系统的稳定性。

围垦和海岸带基础设施建设是沿海地区促进经济发展和保持用地动态平衡的主要途径，也是最近几十年来沿海景观变化的主要原因之一。作为中国的海洋大省，江苏省苏北地区的沿海滩涂资源丰富，围垦历史悠久，自20世纪50年代以来，就经历了4次较大规模的滩涂围垦开发活动，在有效增加后备土地资源、促进沿海农业发展、推进港口建设和临港产业发展、改善基础设施条件、推进沿海城镇建设等方面作出了积极贡献。但随着对土地的迫切需求，围垦速度加快，围垦高程越来越低，部分海岸带滩涂区域的围垦已从高、中滩围垦发展到海平面以下2～1m的低滩围垦，这种对自然生态的影响超出了其生态承载力。

无论是填海造地还是兴建堤坝，其本质都是为了换取更多经济发展的机会和空间。确保海岸带生态环境绝对不退化的确很难，但我们应尽力维系海岸带自然生态系统的动态平衡。目前，比较可行的措施包括在规划设计或工程施工前做好生态评估和环境影响评价，对人工化建设可能带来的生态问题及环境影响的发展趋势、速度、方向等进行分析，以有助于在经济发展效益与生态环境效益之间作出权衡。

我国是否开展过全国尺度上的海岸带生态监测与评估研究？

李：目前，世界各沿海发达国家建立了或正在建立各类针对海岸带或海洋生态系统的监测网络。21世纪以来，中国也开始对海岸带地区18个生态区进行常规性的生态监测，总覆盖范围达5.2万平方公里。2005年，有关部门曾尝试建立我国海洋生态系统服务功能评估方法，并应用于我国四大海域的生态系统服务价值评估。但全国尺度上的海岸带生态监测与评估研究尚未全面开展。在生态文明建设背景下，近年来中国相继出台了一些区域性的生态规划，例如《长江经济带生态环境保护规划》，2005年和2011年，国务院先后颁布的《全国湿地保护工程实施规划（2005–2010年）》和《全国湿地保护工程实施规划（2011–2015年）》也部分包含了海岸带相关内容。但沿海地区目前还没有开展过全国尺度上的完整的海岸带生态保护规划。

对于沿海问题的忽略反映出一种现状，即公众往往习惯于优先关心最容易引起舆论关注的重大环境问题（如华北的雾霾），或者关乎经济发展的重大灾害（如发生在长江经济带地区的地震、滑坡、泥石流、洪涝等），而对于那些难以被明显感知的生态环境问题的关注则明显不足。科学工作者有必要也有责任进行科普宣传，让公众更多地了解到沿海地区生态保护的重要性和迫切性，并开展更具前瞻性的深入研究。

全球气候变暖及海平面上升对中国沿海地区造成了哪些影响？有哪些应对措施？

李：政府间气候变化专门委员会（IPCC）在2014年发表的第五次气候评估

报告中指出，沿海地区是全球气候变暖、海平面上升的关键风险区（或关键脆弱区）。受全球增温及海平面上升影响，台风、风暴潮、暴雨等极端气候事件及由此引发的洪涝灾害等气候变化风险日益增加，严重威胁了全球沿海低洼地区的人类生存和发展，成为国际社会共同面临的重大挑战。根据世界经济合作与发展组织（OECD）的相关研究，全球20个受气候变化影响损失风险最大的城市，其中就有三座中国城市，分别是长江三角洲的上海、宁波，和珠江三角洲的深圳。同时，中国30%以上的海岸地区属于全球气候变暖的高危区域，受风险影响的人口数量居世界第一。[1]

在应对全球气候变暖、海平面上升对沿海地区的影响方面，中国自20世纪80年代以来，在每个“五年计划”中都投入了一定的资金，开展了全球气候变暖、海平面上升影响及适应性等相关研究项目。但真正能做到经济–生态效益双赢，且具有高投入–产出比的适应性措施和解决方案还在摸索当中。在一些非城市地区出现了运用景观学或生物学手段应对海平面上升的方法，如种植能够削缓风浪影响的红树林。就目前来看，这种生物工程适应措施的推广还比较有限，大多数地区仍主要在采取工程性的防护手段。我们期待未来生态学、水文学、工程、景观设计学等多个专业能够联合起来，寻找到更加安全、高效、生态和宜居的解决途径。**LAF**

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2. 建设在自然滩涂湿地上的港口运输码头

2. A pier for transportation built on the natural muddy coast

How would you characterize the ecological and economic situation of China's coastal areas? What important changes have occurred within the coastal landscape in the recent years?

Guosheng LI (LI hereafter): Natural coasts in mainland of China range between rocky, sandy, muddy, and organic coastlines. Rocky coasts are found mostly in the southeastern coastal regions such as the Zhejiang, Fujian, and Guangdong Provinces, and the Shandong Peninsula and Liaodong Peninsula. Sandy coasts are commonly found in areas such as Qinhuangdao and Beidaihe around the Bohai Sea, and other southern coastal regions including provinces such as Guangxi and Hainan. Muddy coastlines are distributed in the regions from the Yangtze River Delta to the northern Jiangsu Province, the area from the Yellow River Delta to the western coast of the Bohai Bay, the Pearl River Delta, the Liao River Delta and the Luan River Delta. The northern Jiangsu Province is one of the world's largest and most typical muddy coasts, which offers opportunities for research.

As coastal urbanization, reclamation, aquaculture, shoal-reinforcement, and oil exploitation have intensified over the past few decades, China's natural coastline has shrunk. The highways between Dalian in Liaoning Province and Nantong in Jiangsu Province, except for the Natural Reserve of Liao River Delta account for nearly half of China's coastline. In Jinzhou, highways are built on the coastline and on the implausibly muddy area between land and sea. Guangdong Province is preparing to build a coastal highway with the hope that it would connect the Pearl River Delta and coastal Guangdong. This type of intensive development has disturbed the natural landscape and ecosystem in coastal zones.

Currently, the man-made coastline accounts for more than 40% of China's total coastline. This is second only to the coastal areas of the North Sea in Europe and a few Pacific Islands where man-made coastal protection infrastructures are necessary due to their low elevations. But, in China, the rapid increase in man-made coastal infrastructure has been driven by demands to create new land reserves for economic growth. China's coastal regions, which are also the most developed areas of the country, contribute over 60% of the national GDP and are home to most major cities with more than 40% of the total population. Limited land has also been the limit for social and economic growth that has resulted in cities reclaiming intertidal zones for urban development and infrastructure such as ports and piers. This development has created a myriad of artificial coastal landscapes.

From your experiences studying China's major delta landscapes — the Yangtze River, the Yellow River, the Pearl

3. 这种苏北沿海地区常见的、绵延几十公里的人工防护堤对当地的自然生态系统造成了干扰。

3. Man-made breakwater commonly found in the northern coastal part of Jiangsu Province. This kind of constructed infrastructure often stretches dozens of kilometers along the coastline, disturbing the natural coastal ecosystem.

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River, and the Liao River Deltas — what is the current ecological and environmental situation in the those deltas?

LI: Among the deltas just mentioned, the Liao River and the Yellow River Deltas are relatively well preserved. This is for two reasons: first, urbanization and economic growth in those regions are less pervasive, and second, the national reserves in these deltas have protected these coastal ecosystems. However, in the recent years, major reed wetlands in the Liao River Delta have been damaged by the construction of offshore oil wells. The reed beds have slowly been replaced by concrete roads.

The Yangtze River and the Pearl River Deltas have faced more intensive urbanization. Although there has been an economic demand to increase growth in the Pearl River Delta, especially where will soon be an important economic growth pole of China's coastal areas driven by the Greater Bay of Guangdong, Hong Kong and Macau, the ecosystem of this area has faced less disturbance thanks to the traditional infrastructure that has maintained self-sufficient energy and material flow system. While mulberry-ponds help to preserve the natural landscape and ecological resources in the delta area, they are being replaced by urban development. Regardless, this ancient wisdom continues to inspire ecological protection and restoration in the region. In part because of the hilly landscape most of the coastal

areas are outside the major ports and harbors in the Pearl River Delta that have restricted urban development and preserved the local natural landscape and ecosystem. Over the past several decades, the natural landscape and ecosystem in the Yangtze River Delta has been significantly changed by rapid economic growth and urbanization resulting in a grievous loss in natural resources.

What do you consider as the balance between social economic development and ecological protection in coastal areas?

LI: Development of the coastal areas in China started during the Tang and Song dynasties. During the Song dynasty, to protect the Jiangsu Province from tidal invasion, a 300-kilometer embankment was constructed. This was called the "Fangong Embankment" in memory of the project's initiator, Zhongyan Fan. The embankment was built of mud and sand which did not completely cut off the hydrological process of the natural wetland system in the coastal area. It had a minimal impact on the local natural ecosystem. However, the current artificial seashore of reinforced steel and concrete structure has worked to destroy the natural landscape and ecosystem, cutting off energy and material flows between the sea and the land.

In more recent decades, reclamation and infrastructure construction have been the main approaches used in the coastal areas to promote economic growth and maintain the dynamic balance in land use. The northern part of Jiangsu, a major maritime province in China, is rich in seashore resources and has a long history of reclamation. Since the 1950s, four large reclamation programs had been launched, contributing to positive increases in reserve lands, promoting coastal agriculture, facilitating harbor development, enhancing coastal infrastructure construction, and improving urban development prospects. Increasing demand for land resources has increased the intensity of land reclamation at lower elevations. In some seashore areas, reclamation has filled in land one to two meters below sea level, affecting the natural ecology and exceeding the ecological capacity.

Reclaiming land from seashore and building embankment are both aim to create space and open opportunity for economic growth. It is difficult to prevent the coastal ecosystem from deteriorating when faced with urban development, but we can work towards planning for balance between development and protection. Ecological assessment and environmental impact analysis can help with the planning, design, and construction of coastal areas, and it can help predict ecological problems and environmental impacts that would be caused by changes in the natural coastline. This can help to inform land use protection to maximize economic, social, and ecological benefits.

Has any nationwide ecological monitoring and assessment on coastal areas ever been conducted in China?

LI: So far as I know, many coastal areas have established various monitoring networks for maritime ecological systems. Since the beginning of the 21st century, China has been carrying out regular ecological monitoring on 18 ecological reserves, covering 52,000 square kilometers in coastal zones. The assessment of maritime ecosystem service of China's four great seas began in 2005. However, nationwide coastal ecological monitoring and assessment has yet to be conducted. In recent years China has initiated more regional ecological planning projects. This includes ecological planning for the Yangtze River economic belt and National Wetland Project (2005 - 2010) and (2011 - 2015). The latter provided guidelines for coastline development and protection. Comprehensive national coastal ecosystem planning still needs to be developed.

The neglect of coastal issues reflects how easily the pubic switches attention to more immediate and more observable environmental problems, such as air pollution haze in

North China and natural disasters such as earthquakes, landslides, and flooding in the Yangtze River Economic Zone. It is important for scientists to improve public education and engagement in order to enhance awareness about the importance and urgency of coastal ecological protection, and to conduct proactive research in related fields.

What is the influence of global warming and sea level rise on China's coastal areas? Can you suggest some interventions?

LI: The IPCC (Intergovernmental Panel on Climate Change) has stated that coastal regions are the key risk and fragile areas threatened by global warming and sea level rise. Extreme climate events, such as typhoons, storm surges and storms, as well as floods and other climate change risks have been increasing. This severely threatens survival and development in coastal lowlands all over the world. The Organization for Economic Co-operation and Development report ranks the top 20 major cities that will be affected by climate change, and three of these are in China, Shanghai and Ningbo in Yangtze River Delta and Shenzhen in Pearl River Delta. Over 30% of China's coastal area is at a high risk to be affected by climate change.[1]

Responding and adapting to global warming and sea level rise is a major worldwide issue. China has been investing every "five-year-plan" in climate change and sea level rise adaptation research since the 1980s. Efforts are still needed to explore and develop adaptive solutions which can be economically and ecologically beneficial. In some non-urban areas, landscape architecture and green infrastructure have been used to deal with sea level rise. For example, planting mangroves to reduce the impact of stormy waves and other adaptive measures have been applied as pilot projects. A safe, efficient, ecological, and beautiful vision for China's coastal areas will be realized through collaborations between ecology, hydrology, engineering, landscape architecture, and other disciplines. **LAF**

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