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厦门大学

硕 士 学 位 论 文

气候变化背景下中国海岸带脆弱性评估

Vulnerability Assessment of Coastal Zone in China under the Background of Climate Change

孙晓萌

指导教师姓名： 彭本荣 教授

专 业 名 称： 环 境 管 理

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摘　要

气候变化与自然和人类社会系统有着密不可分的关系。气候变化所引起的极端天气、海平面上升、冰川消融、生态系统破坏、旱涝灾害等给自然生态系统和社会经济系统平衡带来了严峻的挑战，严重的威胁着人类的生命财产安全。研究分析中国海岸带脆弱性，对完善我国海岸带脆弱性评估方法和指标体系，对我国海岸带管理及制定应对气候变化的战略决策具有重要的现实意义和学术价值。本论文对海岸带脆弱性评估理论进行了系统研究，在此基础上建立了海岸带脆弱性评估的方法和指标体系，并利用 InVEST 模型和 ArcGIS 软件对中国海岸带脆弱性进行了评估。论文取得了如下研究成果。

1) 论文在系统研究脆弱性理论的基础上，从自然生态系统脆弱性、人类社会系统脆弱性、人类—自然耦合系统脆弱性三个方面构建了脆弱性评估框架和指标体系。建立的海岸带脆弱性评估指标体系包括：一个一级指标脆弱性（V），三个二级指标暴露程度（E）、敏感性（S）及适应能力（A）和 17 个三级指标，主要包含自然和社会经济两方面因素；

2) 论文建立了海岸带脆弱性评估方法，包括三级指标的相对赋值系统，二级指标（暴露程度、敏感性和适应能力）几何平均计算方法、一级指标（脆弱性指数）计算模型以及脆弱性分类评估方法；

3) 论文以 ArcGIS 及 InVEST 为平台进行空间分析和处理，对全国每公里岸段的脆弱性进行了评估。结果显示，脆弱指数最小值为 0.51，最大值为 11.72。全国脆弱指数平均值为 3.68，有 12.69 %为高度脆弱性岸段，37.57 %为低脆弱性岸段，其余 49.74 %为中等脆弱程度。全国有 284.62 万人口，1057.36 亿元的 GDP 位于高脆弱性岸段 3 km 缓冲区，占 3 km 缓冲区内人口和 GDP 比例为 7.48 %和 4.13 %。高脆弱区集中在人均 GDP 相对较低和基础设施相对较不完善的地区，说明适应能力对脆弱性指数影响较大。从脆弱性二级指标看，全国高暴露岸段比例为 18.84 %，低暴露比例为 28.24 %；高敏感岸段为 25.59 %，低敏感为 16.67 %；适应能力强的岸段为 18.07 %，适应能力弱的岸段为 24.91 %；

4) 论文对环渤海经济区、长三角经济区、海西经济区、珠三角经济区四个主要经济区的脆弱性进行了评估。四个经济区的脆弱性指数加权平均值分别为 3.43、4.54、2.21、4.16；高脆弱性岸段占该区域总岸段长度的百分比依次是 9.63 %、

21.22 %、0 %、18.99 %；四个经济区高脆弱性岸段占全国高脆弱岸段的比例分别为 23.62 %、34.69 %、0 %、36.07 %。从区域整体脆弱程度来看，长三角经济区的整体脆弱程度最高，其次是珠三角经济区，海西经济区脆弱性最低；

5) 论文对海岸带自然生境（红树林、珊瑚礁、海草床和盐沼）对海岸带脆弱性的影响进行了评估。结果显示，在无生境情况下，全国高脆弱岸段增加了 226 个，全国脆弱指数提高了 0.11；高脆弱性岸段的人口和 GDP 分别增加了 39.40 万人和 102.01 亿元；环渤海、长三角、海西、珠三角脆弱性指数分别提高了 0.02、0.08、0.06、0.25。由此可以看出，海岸带自然生境对减少海岸带脆弱性进而减缓气候变化的影响具有重要作用。

关键词：脆弱性；海岸带；暴露程度；敏感性；适应能力

Abstract

Climate change had close ties with nature and human-society system. Extreme weather, sea level rise, glaciers, ecosystem destruction, and drought and flooding disasters resulted from climate change had brought increasingly serious challenges to the balance of natural ecology and social-economy system and threaten the safety of human health, life and property. Study of the vulnerability in China's coastal zone could contribute significantly to academic value in perfecting the vulnerability assessment method and evaluation index system, and provided scientific support to integrated coastal management and strategic decision-making of adaptation and mitigation to the climate change in coastal zone. On the basis of systemic research in coastal vulnerability assessment theory, this paper established coastal vulnerability assessment methods and index system, using InVEST model and ArcGIS to calculate and evaluate the vulnerability in China's coastal zone. The main achievements of the dissertation were as follows:

1) On the basis of researching coastal vulnerability assessment theory systemically, this article established vulnerability assessment conceptual framework and index system from three aspects: natural ecological system vulnerability, human-social system vulnerability, human-natural coupling system. The established coastal vulnerability assessment index system including: One first class indicator vulnerability (V), three second class indicators exposure (E), sensitivity (S) and adaptability (A) and 17 third class indicators which mainly included nature and social economic two aspects factors.

2) This paper established coastal vulnerability assessment methods, including relative assignment system for the third class indicators, geometric average method for the second class indicators (exposure, sensitivity and adaptability), calculation model for the first class indicator (vulnerability) and vulnerability classification assessment method.

3) The paper was mainly based on ArcGIS and InVEST as a platform for spatial analysis and processing to assessment coastal vulnerability in 1 km^2 segements in a

nationwide.The results showed that the minimum value of vulnerability is 0.51, and the maximum value is 11.72.National average vulnerability was 3.68. There were 12.69 % coastal segments belonging to highest vulnerable degree, 37.57 % segments were lowest vulnerable degree, and the rest were intermidiate segments. In nationwide, 2.8462 million people and 105.736 billion yuan GDP located in the 3 km buffer of highest vulnerable areas, making up to 7.48 %, 4.13 % of the total population and GDP within the 3 km buffer areas. Highest vulnerable area concentrated in areas where per capita GDP was relatively low and infrastructure was relatively incomplete, showing great influence of adaptability on vulnerability value. From the point of second class indicators ,the proportion of coastal segments exposed to highest exposure was 18.84 %, the lowest exposure was 28.24 %. The proportion of coastal segments in highest sensitivity was 25.59 %, the lowest sensitivity was 16.67 %. As to adaptability, highest adaptable coastal segments accounted for 18.07 %, and the percentage of lowest adaptable coastal segments was 24.91 %.

4) The article assessmented the vulnerability of four major economic zones: Bohai Economic Zone, the Yangtze River Delta, the Economic Zone on the West Side and the Pearl River Delta Economic Zone. Weighted average values of vulnerability index in four economic zones were 3.43, 4.54, 2.21, 4.16, respectively; Highest vulnerability segments in each region accounted for 9.63 %, 21.22 %, 0 %, 21.22 % of the total length of certain region; The highest vulnerability segments in each region occupied 23.62 %, 34.69 %, 0, 36.07 % respectively of national highest vulnerability segments. From the point of overall regional vulnerable degree, the Yangtze River Delta's overall vulnerable degree was the highest ,then the Pearl River Delta Economic Zone, and the Economic Zone on the West Side was the lowest.

5) The paper assessmented impacts of natural habitats (Mangrove, Coral Reef, Seagrass beds and Saltmarsh) on the vulnerability in coastal zone. In the absence of habitats, the results showed that the number of highest vulnerability segments increased 226, and the weighted average of national vulnerability index increased 0.113. People and GDP in highest vulnerability areas increased by 0.39 million people and 10.201 billion yuan and respectively. Bohai Economic Zone, the Yangtze River

Delta, the Economic Zone on the West Side and the Pearl River Delta Economic Zone were increased by 0.02, 0.08, 0.06, 0.25, respectively, from which we could come to the conclusion that coastal natural habitats played an important role on reducing the coastal vulnerability and then mitigating the impacts of climate change.

Key Words: Vulnerability; Coastal Zone; Exposure; Sensitivity; Adaptability

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