研究报告

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基于MEA情景的长江流域氮平衡及溶解态无机氮通量:流域-河口/海湾氮综合管理

Future nitrogen balance and dissolved inorganic nitrogen flux from the Yangtze River basin to coastal bay under the framework of the Millennium Ecosystem Assessment

关键词: 千年生态系统评估 长江流域 氮循环 模型
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摘要: 以长江流域氮循环为研究对象,基于千年生态系统评估框架下的4种情景,预测了2050年长江流域的氮循环在不同驱动因子作用下的未来变化趋势,并提出长江流域生态系统的优化管理的建议.研究结果表明,在1970-2010年期间,长江流域氮输入量增加了5倍,长江向河口输出的溶解态无机氮(DIN)通量增加了8倍,流域土壤中的氮已经达到饱和并且氮过剩量持续增加,流域对氮的截留率下降,水体输送的DIN通量增加,区域氮循环失衡问题日益严重.在千年生态系统评估框架下,预测在2050年,在采取积极措施的预测情境下,河流向河口和近海输送的溶解态无机氮通量将会比2000年有所下降,而在消极应对的预测情境下,河流向河口和近海输送的溶解态无机氮通量将会继续增加,从而加剧河口和近海地区水体的污染程度.非点源氮输入将是长江溶解态无机氮输出通量的主要来源,其中以化肥氮输入为主,其次为禽畜粪便氮输入,贡献率最低的是点源污水氮输入.情景预测及源解析研究表明,2050年长江流域-河口/海湾氮污染控制的重点在于减少长江下游-太湖流域、沅江-湘江-洞庭湖流域、赣江-鄱阳湖流域及岷江流域的化肥及畜禽粪便排放,2050年要实现长江水系水质全面达标,长江流域的氮输入量需要削减29%,其中长江下游-太湖流域削减40%,汉江流域削减43%,沅江-湘江-洞庭湖流域削减31%.从子流域尺度制定氮污染管理策略更适用于流域-河口/海湾系统框架下的综合管理.

Abstract: According to the four scenarios under the framework of the Millennium Ecosystem Assessment (MEA), the changing of nitrogen cycling in the Yangtze River basin in 2050 has been modeled based on the changing driving factors. The results have shown that nitrogen input has increased about 5 times in the basin in the past 30 years, while the dissolved inorganic nitrogen (DIN) flux has increased 6 times from the Yangtze River to the estuary in the same period. The basin has reached nitrogen saturation and the N surplus continued to increase. There is a significant decrease of nitrogen retention rate and an increase of river DIN export. The imbalance of nitrogen cycle is in a serious situation in the Yangtze River basin. Based on the forecast data of MEA, in the scenarios with a proactive attitude, N balance and DIN exports decrease in the basin. While the scenarios with a reactive approach to environmental problems show increases in N balance and DIN flux. Water pollution in the estuary and offshore areas will be very serious as a result. The non-point sources nitrogen inputs contributed more to the river DIN flux than point sources nitrogen inputs. Especially, the fertilizer and animal manure contributed most of the nitrogen to the river DIN flux than atmospheric nitrogen deposition biological nitrogen fixation and point sources. The point sources of sewage nitrogen inputs contributed the less. Scenarios analysis and source tracking suggests at least 40% (Yangtze river downstream-Taihu lake basin, with emphasis on fertilizer), 43% (Hanjiang watershed, with emphasis on fertilizer and animal manure) and 31% (Yuanjiang-Xiangjiang-Dongting Lake watershed, with emphasis on fertilizer and animal manure) reduction of anthropogenic inputs to improve water quality and mitigate eutrophication in both river and coastal waters. Nutrient management strategies should be applied at sub-basin scale and within an integrated watershed-coast framework. Spatial analysis indicated that the highest N inputs and DIN fluxes would be at 3 sub basins, the Dongting Lake basin, Poyang Lake basin and the Taihu Basin. Therefore, fertilizer and animal manure are the key factors to optimize the management of the 3 sub basins of the Yangtze River basin.

Key words: Millennium Ecosystem Assessment (MEA) the Yangtze River basin nitrogen cycling model