

Is afforestation for carbon sinks an effective way to achieve carbon neutrality?

——The Case of Northwest China

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Abstract: Afforestation is considered to be a promising way to mitigate climate change. However, its cost-effectiveness should be carefully evaluated, especially for regions with fragile environment and vulnerable ecosystem. This study develops a geographic-economic-ecological integration framework to evaluate the cost-effectiveness of afforestation for carbon sequestration in Northwest China. Based on the overlay model of natural factors and the economic optimization model of land use, the marginal land suitable for afforestation is identified. Then, the Richards growth function is employed to estimate the carbon sequestration potential of afforestation. Based on this, the carbon supply curve is fitted and the cost-effectiveness of afforestation for carbon sequestration is investigated. (1) In Northwest China, 499.58×10^4 hectare of land is ecologically available for afforestation. However, only 102.71×10^4 hectare of these lands are economically feasible for afforestation, accounting for about 1/5 of ecologically available land. The lands suitable for afforestation are primarily grasslands and unused lands, which are mainly distributed in Qinghai and Gansu provinces. (2) Afforestation has a potential of carbon sinks with 9.37 million tons of CO₂ per year in Northwest China. By 2060, this potential will cumulatively be 374.88 million tons of CO₂, which can contribute 9.70%-15.06% of the region's carbon neutrality. (3) The marginal cost of forest carbon is 153.72-1499.67 CNY/tCO₂ in Northwest China, with an average cost of 948.81 CNY/tCO₂. Compared with industrial emissions reduction, afforestation does not have cost-effectiveness to mitigate climate change in Northwest China. Additionally, afforestation would become even less cost-effective when consider the urgency of government to address climate change. The potential for carbon sequestration by afforestation in the Northwest is limited. And after considering the ecological opportunity cost, it is not cost-effective compared with the production and economic emission reduction. These findings provide policy implications in designing and implementing carbon neutrality strategies.

造林增汇是实现碳中和的有效途径吗？

——以西北地区为例

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摘要:造林增汇是减缓气候变化的重要方式,但其碳中和效果背后的成本有效性不可忽视,这对西北干旱半干旱地区尤为重要,亟需评价西北地区造林增汇的成本有效性。该研究构建了地理-经济-生态三维整合分析框架,基于地理信息系统的方法,采用环境因子叠加模型和土地利用动态优化模型,从自然可行性和经济可行性两个角度识别了西北地区边际可造林区域,采用 Richards 生长方程预测了造林碳汇潜力,以此为基础拟合了碳汇供给曲线,并对西北地区造林增汇的成本有效性进行了评价。①西北地区满足自然可行性的造林面积为 499.58 万公顷,但其中仅有 102.71 万公顷满足自然和经济双重可行性,占比约为 20.56%。其中以草地和未利用地为主,主要分布在青海和甘肃两省。②西北地区造林的碳汇潜力为 9.37MtCO₂/年,到 2060 年,西北地区通过造林将会增汇 374.88MtCO₂,能够为该地区碳中和目标提供约 9.70%~15.06%的贡献。③西北地区造林增汇的边际成本区间为 153.72~1499.67 元/tCO₂,平均成本为 948.81 元/tCO₂,相比于 680 元/t 的二氧化碳边际减排成本,整体上不具有成本有效性。在碳实物贴现率为 5%的情景下,西北地区造林增汇的成本有效性更弱。西北地区造林增汇潜力有限,且在考虑生态环境机会成本后,与产经减排相比,不具有成本有效性,据此,提出强化造林增汇对碳中和贡献的政策建议。