

生态系统碳汇发展的国际进展与中国展望

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摘要

应对气候变化是国际社会广泛达成的共识，生态系统的固碳增汇功能在应对气候变化中具有重要潜力。面对不断升级的环境挑战，世界各国越来越多地将基于自然的解决方案（Nature-based Solutions, NbS）作为协同解决气候变化、生物多样性丧失等多边议程的整体方法。据估计，到 2030 年，在所有生态系统中实施 NbS 可以实现每年至少 50-117 亿吨二氧化碳当量的减排和清除。世界各国尤其是发达国家在发挥生态系统碳汇功能的过程中制定了一系列管理措施，跨国公司也在 NbS 投资方面积极作为。企业减排需求持续增加推动全球自愿碳信用年需求快速增长，其中林业、农业和土地利用等 NbS 碳信用产生量呈现上升趋势。预计 2030 年全球自愿碳市场每年将提供 26 亿吨二氧化碳当量的交易额。

中国在提升生态碳汇功能上取得积极进展，发挥生态系统碳汇功能具有成本和技术优势。2021 年，中国印发《2030 年前碳达峰行动方案》，碳汇能力巩固提升被列为“碳达峰十大行动”之一。中国目前林地、草地、湿地总面积达 60.5 亿公顷，林草覆盖率达 55.11%，林草总碳储量 114.43 亿吨，年碳汇量 12.80 亿吨。中国通过增加面积、减少损失、提高质量三条路径提升森林碳汇功能，实现了森林面积和森林蓄积保持连续 30 年“双增长”，成为全球森林资源增长最快最多的国家。中国推进山水林田湖草沙一体化保护和修复，

创造了一大批以塞罕坝林场为代表的兼具生态、经济与社会效益的良好实践，将绿水青山转化为金山银山，促进应对气候变化、生物多样性保护、经济社会发展方面协同增效。中国还积极与国际社会开展合作，为全球打造示范案例，共同推进 NbS 主流化。

未来，中国可以从三个方面巩固提升生态系统碳汇功能，更好助力实现“双碳”目标。第一，优化自然资源管理政策，调动经营主体生产经营积极性。一是优先发挥国有林碳汇价值，健全国有林场管理体制，促进林木有效保护和科学利用。深化集体林权制度改革，明确林地产权与林业碳汇产权的权属关系，设定合理的碳汇交易利益分配机制。二是优化林草资源开发政策，健全林木采伐管理，推进林地适度规模经营，健全林草业生态产品价值实现机制，提升可持续经营水平。三是全面提升林草业科技支撑水平，提高林草业机械化水平，推动大径材、高质草的发展，发展木竹加工、林业生物质能源等产业，开拓林木业多元发展空间。

第二，完善碳抵消机制设计，打造引领国际的自愿减排市场。一是加快生态系统 MRV 标准化建设，应用卫星等信息化技术，完善区域尺度地面调查，逐步推动国家生态碳汇核算与国际接轨，提高自愿碳信用市场的可信度。二是加强碳汇项目监管和信息公开，完善企业参与碳抵消的披露准则，加强碳汇项目信息化建设，引入第三方评估机构，提高自愿碳信用市场的透明度。三是推动“一带一路”国家共建高透明度、高流动性的大规模自愿碳市场，形成稳定的价格机制，规避潜在市场风险。

第三，充分调动社会资本，助力生态碳汇项目投融资。一是创新财税金融支持政策，发展林草相关债券、保险等绿色金融产品和金融工具，探索政府和社会资本合作等模式。二是引导企业和金融机构完善相关规则标准，考

考虑将碳信用纳入机构净零目标，丰富 ESG 评价指标体系，减少对自然负面活动的融资。三是深化绿色金融国际合作，将更多 NbS 项目纳入绿色金融目录，鼓励发展中国家探索适合各自国情的 NbS 路径和做法，厘清发达国家参与 NbS 项目投资与减缓气候变化出资责任的关系。

应对气候变化是国际共识。在《巴黎协定》下，各国纷纷设定减排目标和实施路径，不仅控制能源、工业和交通等重点行业的碳排放，还关注生态系统的减排增汇作用。随着能源和工业等高排放部门的剩余碳排放减排成本越来越高，生态系统碳汇功能被认为是实现“双碳”目标不可或缺且具有成本优势的碳移除手段。基于自然的解决方案（Nature-based Solutions, NbS）被视为提升生态系统碳汇功能的主要措施，是全球实现气候变化目标的整体策略和行动的重要组成部分，对于碳减排、降低气候变化风险以及提升气候韧性具有重要意义。

一、发挥生态系统碳汇功能的国际进展

生态系统的固碳增汇功能在应对气候变化中具有重要潜力。陆地和海洋是地球生态系统天然碳汇的来源。陆地生态系统碳汇通常被称为“绿碳”，其中森林占主导地位，管理良好的草原、湿地、土壤亦可成为碳汇，海洋活动及海洋生物捕获的碳通常被称为“蓝碳”。NbS 是发挥生态系统碳汇功能的直接手段，也可称为供给端措施。NbS 是指采取行动保护、可持续管理和恢复自然或改良生态系统，以有效和适应性地应对社会挑战，增进人类福祉和生物多样性收益。据估计，到 2030 年，在所有生态系统中实施的 NbS 可以实现每年至少 50 亿吨二氧化碳当量的减排和清除量，最大估计为每年 117 亿吨二氧化碳当量；到 2050 年，这将上升到每年至少 100 亿吨二氧化碳当量，最高估计为每年 180 亿吨二氧化碳当量。其中，约 62%的贡献来自与森林有关的解决方案，约 24%来自草原和农田的解决方案。NbS 的基本思路主要包括三个方面：一是保护生态系统免于转为其它用途，这也是首要任务；二是从源头或驱动因素解决生态系统退化问题；三是恢复生态系统。相应地，增汇有三种路径：一是保护措施，即避免林地、草地、湿地、沿海湿地等转化为

其它用途；二是管理措施，包括天然林的可持续管理、火灾管理、农林业混合经营、轮牧和保护性耕作等，政府可采取提供补贴、提供培训和土地产权改革等措施促进生态系统的可持续管理；三是恢复措施，例如造林和再造林等。

基于自然的解决方案逐渐成为全球协同解决应对气候变化、生物多样性丧失等多边议程的整体方法。2008年，世界银行发布《生物多样性、气候变化和适应：世界银行投资中的基于自然的解决方案》报告，首次提出可以将NbS作为一种新的解决方案，在缓解和适应气候变化影响的同时，保护生物多样性并改善可持续生计。2009年，世界自然保护联盟（IUCN）在提交给《联合国气候变化框架公约》第15届缔约方大会的建议报告中提出，积极推动将NbS作为更广泛的减缓和适应气候变化整体计划和策略的重要组成部分，并于2016年进一步明确了基于自然的解决方案的概念和内涵。2019年，在联合国秘书长的倡议下，NbS被联合国气候变化大会列为“应对气候变化的全球九项重要行动”之一。2023年，《联合国气候变化框架公约》第28次缔约方会议达成“阿联酋共识”，鼓励采用NbS等方法减缓气候对生态系统和生物多样性的影响。2022年，流向NbS的年度资金总额为2000亿美元，同比增长11%，其中公共财政占比82%，私人融资规模占比18%。同时，每向NbS投入100万美元，将创造至多40个工作岗位，几乎是投资化石燃料所能够提供就业机会的10倍。

世界各国尤其是发达国家积极发挥森林等生态系统固碳增汇功能。主要国家和地区积极推动将NbS纳入国家治理、气候行动以及政策工具。2015年，欧盟将NbS纳入“地平线2020”官方综合性科研计划。2022年，美国拜登政府发布《美国NbS路线图》，指导美国充分释放NbS潜力，应对气候变化、

自然损失和不平等问题，并将提供 250 亿美元以上的资金支持 NbS 实施；美国国际发展署发布的《2022-2030 气候战略》特别强调了 NbS 作为固碳、减少灾害风险、支持生计、改善食物和水安全的关键工具；加拿大正式实施的首个《国家适应气候变化战略》特别提到利用 NbS 提升气候韧性并最大限度地实现协同效益。跨国公司也在 NbS 投资方面积极作为。2019 年，澳大利亚必和必拓公司宣布在未来五年内计划投入 4 亿美元用于支持减排技术的研发和部署，减少集团在运营过程中以及下游企业在使用必和必拓资源产品生产过程中的碳排放量，并将推动对 NBS 的投资。2022 年，必和必拓在澳大利亚资助了三个蓝碳项目，计划在三年内提供超过 500 万澳元支持海洋减排。

全球已建立多种自愿减排机制，促进生态系统碳汇减排效果的量化核证和交易。碳信用市场主要分为三类，包括京都议定书和巴黎协定所建立的国际碳信用机制、本土建立的碳信用机制、非政府的独立碳信用机制。国际主流碳信用机制包括清洁发展机制(CDM)、核证碳标准(VCS)、黄金标准(GS)、中国国家核证自愿减排机制 (CCER)、美国碳登记 (ACR)、气候行动储备 (CAR)、REDD+交易构架 (ART) 和全球碳委员会 (GCC) 等。其中，VCS 是目前最大的独立碳信用机制，也是森林保护、可持续管理和增加森林碳汇 (REDD+) 与林业碳信用的最大签发者，其他碳汇参与自愿减排市场的模式大多是通过造林/再造林。公司或组织机构通过自愿购买碳信用，可以抵消自身未能避免的温室气体排放量。由于全球范围内企业减排需求持续增加，全球自愿碳市场的发展非常迅速，推动全球自愿碳信用年需求快速增长。据世界银行统计，2021 年全球三大类碳信用主要供给机制签发的碳信用数量达到 4.78 亿吨二氧化碳当量。世界经济论坛表明，2030 年全球自愿碳市场每年将提供 26 亿吨二氧化碳当量的碳交易额度。当前可再生能源项目是碳信用产生

的主要来源，林业、农业和土地利用等 NbS 碳信用产生量呈现上升趋势，2022 年 54% 的新项目注册属于林业和土地利用活动。2022 年，全球自愿碳市场吸引了 12 亿美元的投资。美国环保协会预测，2030 年全球自愿碳市场的规模保守估值在 50 亿至 300 亿美元之间，甚至可能达到 500 亿美元。

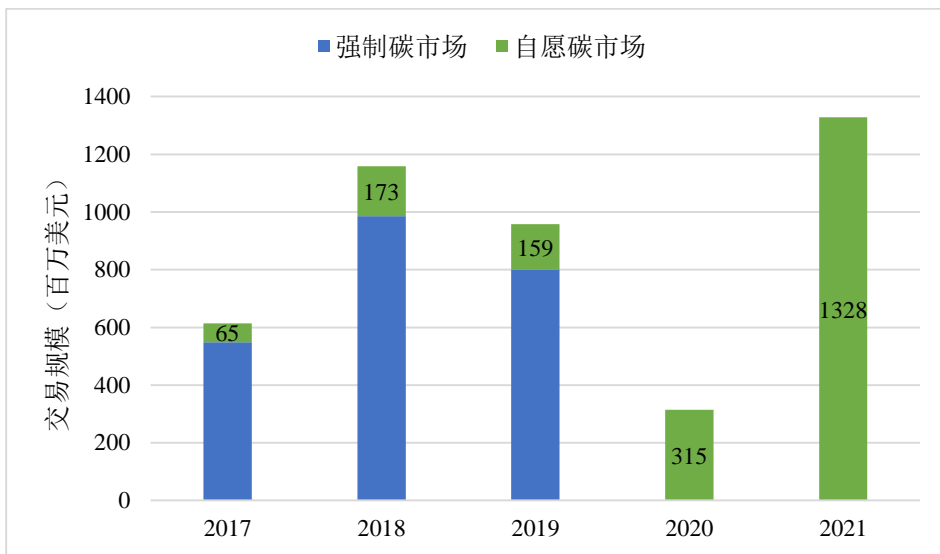


图 1 基于林业及土地利用相关的全球自愿碳市场和强制碳市场规模
 注：2020-2021 年强制碳市场相关数据缺失。
 数据来源：Center for Global Development (2023)

二、推动生态系统碳汇功能实现的中国实践

不断完善以国家核证自愿减排机制为主体的全国温室气体自愿减排交易市场建设。国家核证自愿减排量 (CCER) 是指对我国境内可再生能源、林业碳汇、甲烷利用等项目的温室气体减排效果进行量化核证，并在国家温室气体自愿减排交易注册登记系统中登记的温室气体减排量。国家核证自愿减排交易是强制碳市场的补充机制，当控排企业配额不足时可购买配额或核证自愿减排量抵消^①。2012 年，国家发展改革委发布《温室气体自愿减排交易管

^① 为了避免企业减排动力不足，规定抵销比例不得超过应清缴碳排放配额的 5%。

理暂行办法》和《温室气体自愿减排项目审定与核证指南》。2013年起，多个区域碳交易试点启动，通过将CCER项目纳入抵消机制，为CCER创造了预期稳定的规模化需求。2017年，国家发展改革委启动对《温室气体自愿减排交易管理暂行办法》的修订工作，CCER项目备案审批和减排量签发暂停，但不影响已备案的CCER参与交易。2023年，生态环境部、市场监管总局联合发布《温室气体自愿减排交易管理办法（试行）》。2024年初，全国温室气体自愿减排交易市场已正式重启。

发挥生态系统碳汇功能的成本和技术优势。碳汇供给是碳汇市场交易的基础。中国目前林地、草地、湿地总面积达60.5亿公顷，林草覆盖率达到55.11%，林草总碳储量114.43亿吨，年碳汇量12.80亿吨。其中，森林资源在促进发挥生态系统碳汇功能方面具有较大优势。中国通过增加面积、减少损失、提高质量三条路径提升森林碳汇功能。在增加面积方面，中国通过三北防护林工程、退耕还林还草工程、京津风沙源治理工程、速生丰产用材林为主的林业产业基地建设工程、国家储备林项目等造林工程和项目增加了大量的森林，其中三北防护林体系建设工程涵盖了95%以上的风沙危害区和40%的水土流失区，40年间，工程区森林面积净增加2156万公顷，森林覆盖率由5.05%提高到13.57%，固碳累计达到23.1亿吨二氧化碳当量，相当于1980年至2015年全国工业二氧化碳排放总量的5.23%。目前全国森林面积2.31亿公顷，蓄积194.93亿立方米，中国森林面积和森林蓄积保持连续30年“双增长”，成为全球森林资源增长最快最多的国家。预计2050年，在森林覆被率从24%增加至28%以及单位面积蓄积量达到世界平均水平的条件下，中国年新增碳汇能力将达约10-15亿吨二氧化碳当量。在控制减少与退化方面，中国通过天然林保护工程、防沙治沙工程、森林草原防灭火一体化体系建设、

林草有害生物防治等工程与措施，实现了森林火灾起数、伤亡人数、受害面积均降至历史最低位，同时，也对森林病虫害防治持续加大政策力度。此外，中国还通过低产低效林改造项目、森林质量提升项目、草原奖补政策、湿地保护修复等项目有效提高森林、草原、湿地的质量，为生态系统碳汇的有效供给提供了保障。

表 1 全球代表性国家森林资源主要指标

	森林面积 (千公顷)	森林覆盖率 (%)	森林单位蓄积 (m ³ /ha)	单位面积碳储量变化 (Mg C/ha/yr)
全球	3999135	30.7	131	1.04
中国	220446	22.96	94.83	1.22
新西兰	10152	38.6	392	1.05
美国	310095	33.8	131	0.94
德国	11419	32.8	321	1.68
日本	24958	68.5	196.3	1.59

发挥基于自然的解决方案的生态、经济与社会协同效益。2021年，中国印发《2030年前碳达峰行动方案》，碳汇能力巩固提升被列为“碳达峰十大行动”之一。中国坚持系统观念，推进山水林田湖草沙一体化保护和修复，提高生态系统质量和稳定性，提升生态系统碳汇增量。工作实施重点在森林、草原和耕地三类生态系统，以保护和修复措施为主，主要包括森林质量精准提升工程和耕地质量提升行动，以及退耕还林等其他具备多重效益的措施。森林经营等碳汇能力提升措施不仅能够提供碳汇产生生态效益，还能通过发展林下经济、开发森林康养、森林旅游等途径，增加营林者的收入，创造更多的就业机会，从而实现生态、经济与社会协同效益，将绿水青山转化为金山银山。这不仅有助于实现“双碳”目标，也对巩固脱贫攻坚成果、实现乡村振兴、促进共同富裕具有重要意义。三代塞罕坝人成功营造出总面积 112 万亩、

森林覆盖率达到 80%的世界最大人工林海，每年产生的生态服务价值达 142 亿元，为京津地区输送净水 1.37 亿立方米、释放氧气 57.06 万吨、固定二氧化碳 81.41 万吨，成为守卫京津的重要生态屏障。塞罕坝国家级森林公园每年接待游客稳定在 50 万人次以上，直接提供临时就业岗位约 1.5 万个，带动周边百姓发展乡村旅游、山野特产、手工工艺、交通运输等外围产业，每年实现社会总收入 6 亿多元。浙江安吉竹林碳汇项目以林地经营权为质押，向银行申请绿色贷款以解决林业融资难的问题，通过建立“林地流转-碳汇收储-基地经营-平台交易-收益反哺”的全链条体系，探索“企业+合作社+林农”的经营模式和利益共享机制，充分发挥竹林生长周期短、固碳能力强的优势，持续稳定产生碳汇收益。

与国际社会积极开展合作共同推进基于自然的解决方案的主流化。2019 年，联合国气候行动峰会确定由中国和新西兰作为 NbS 行动的联合牵头国，共同发布 NbS 联盟的成果，包括《基于自然的气候解决方案政策主张》和《联合国气候行动峰会 NBS 倡议案例汇编》。2021 年，中国自然资源部与 IUCN 开展合作，联合发布了《IUCN 基于自然的解决方案全球标准》《IUCN 基于自然的解决方案全球标准使用指南》中文版，并结合中国生态保护和修复重大工程与实践在全国范围内选取了 10 个代表性案例，分别是官厅水库流域治理、贺兰山生态保护修复、云南抚仙湖流域治理、内蒙古乌梁素海流域保护修复、钱塘江源头区域保护修复、江西婺源乡村建设、黑龙江黑土地保护性利用、重庆城市更新、广西北海陆海统筹生态修复和深圳湾红树林湿地修复，对中国乃至全球 NbS 本地化具有良好的示范和借鉴作用。2021 年，《联合国气候变化框架公约》第 26 次缔约方大会前夕，中国向公约秘书处提交《本世纪中叶长期温室气体低排放发展战略》，NbS 被列为十个战略重点及政策导向

之一，提出要积极发挥 NbS 在温室气体减排与增汇方面的潜力，形成减排增汇的国土空间布局和生态系统、推动农业绿色低碳转型、加强生态系统保护修复和碳储存。2023 年 5 月，中国自然资源部与 IUCN 签署协议，共同建立 NbS 亚洲中心，旨在通过 NbS 的研究、实践和国际合作，追求中国政府所倡导的可持续发展和生态文明理念，促进人类与自然和谐共处。

三、中国巩固提升生态系统碳汇功能的未来展望

随着中国碳减排进程的推进，技术减排潜力收窄，减排成本不断上升，基于自然的解方案能够依靠生态功能增加碳汇以抵消碳排放，有利于激发资源更有效利用，促进应对气候变化、生物多样性保护、经济社会发展等方面的协同效应，降低碳减排社会成本，提高气候韧性，助力碳中和。

第一，优化自然资源管理政策，激发森林碳汇固碳潜力。

当前中国森林（面积世界第五，蓄积第六）、草原（世界第二）、湿地（世界第四）面积都很大，可进一步完善林草业资源管理相关政策，更好平衡林草资源的有效保护和科学利用，统筹实现林草业高质量发展和高水平保护，激发林草资源碳汇空间。

深化林草业产权和制度改革，激发林草业经营主体生产经营积极性。国有林的森林资源质量高于分散的集体林^②，可考虑优先发挥国有林碳汇价值。健全国有林区 and 国有林场管理体制，设定灵活的财政政策，强化地方政府对林业经营的政策扶持，增加生产经营性活动预算，制定激励性薪酬制度，鼓励开发林业碳汇项目，促进森林保护和利用政策的有效执行。深化集体林权制度改革，推行集体林地所有权、承包权、经营权的分置。以法律形式明确林地产权与林业碳汇产权的权属关系，设定合理的碳汇交易利益分配机制，

^② 根据第九次森林资源清查结果，占全国森林面积 61.34%的集体林蓄积量相当于国有林蓄积的 68.51%。

保障经营主体收益占比。

优化林草资源开发政策，健全生态产品价值实现机制。合理放开森林采伐限额，满足森林经营中合理的采伐需求。培育新型林业经营主体和生产基地，推进林地适度规模经营，提高森林经营效率和科学性。建立健全能够体现碳汇价值的生态保护补偿机制，对公益林和商品林发挥的正外部性均给予补偿。健全森林生态产品标志管理和产品追溯体系，创造更高的森林产品附加价值，加强林草资源可持续经营水平。加强地方层面生态碳汇开发利用相关教育培训，引进和培育专业服务机构，避免碳汇项目潜在风险隐患。

全面提升林草业科技支撑水平，开拓林木业多元发展空间。提升林草业机械化水平，推动发展大径材、高质草，充分发挥木质林产品的固碳作用、材料替代效应和能源替代效应，为林草产业创造更高收益，实现经济和生态的双赢。加快发展木竹加工、林业生物质能源等绿色低碳产业，推动现代林业产业与其他产业相融合，健全林产品加工和林业资源开发利用的全产业链。鼓励研发新型木材，发展木结构建筑，增加林木产品多元化发展，有效对接各类林木市场需求。

第二，完善碳抵消机制设计，打造引领国际的自愿减排市场。

自愿减排交易市场是助力国家和企业碳中和的重要市场机制，是推动碳抵消市场深化发展、实现低成本减排的重要工具，对于鼓励全社会共同参与减排具有积极意义。可进一步完善生态碳汇监测核算等体制机制，提高碳信用抵消机制的可信度、透明性和联通性，提高自愿减排市场的活跃度和有效性。

加快生态系统 MRV 标准化建设，提高自愿碳市场的可信度。在地区层面，生态碳汇核算应力求准确，采用小区域尺度，应用卫星等信息化技术，

完善地面调查，确保基础数据准确性。在国家层面，推动生态碳汇核算逐步与国际接轨，符合 IPCC 的核算原则，确保核算结果具有国际可比性。积极参与制定各领域生态碳汇交易的国际标准。地区和国家层面的生态碳汇监测、报告、核查（MRV）应互联互通，确保不同层面碳汇核算结果协调一致，提升碳汇监测的可靠性。

加强碳汇项目监管和信息公开，提高自愿碳市场的透明度。加强监管机构对自愿碳市场的活动的指导，健全企业参与碳汇项目全流程监测，提高项目执行透明度，全面提升碳信用审定核查质量。鼓励企业公布自愿碳交易情况，通过完善企业参与碳抵消的披露准则，避免企业“漂绿”风险并加强相关监管。建立全国森林、草原、海洋等生态系统碳汇数据库，加强生态碳汇项目的信息化建设，促进碳汇开发和交易的可持续性。引入第三方评估机构，避免企业自行评估造成评估失真等情况，提高交易的公平性。

逐步推动共建全球性的自愿碳市场，提高自愿碳市场的联通性。国际自愿碳市场建设方兴未艾，中国可抓住机遇参与相关国际规则标准的制定和完善。推动“一带一路”国家共建自愿减排交易市场，优化现有碳抵消机制分散、小规模的状态，推动建立高透明度、高流动性的全球性大规模自愿碳市场，形成有利于发展中国家的稳定的价格机制，并帮助发展中国家规避碳信用市场潜在交易风险。考虑提出“自愿碳市场诚信倡议”，通过碳信用机制加强气候变化领域国际合作，提高中国在国际气候领域的话语权。

第三，充分调动社会资本，助力生态碳汇项目投融资。

生态系统尤其是森林的碳汇项目将为减缓气候变化提供新力量，是探索人与自然和谐发展的有利途径。当前气候领域资金存在巨大缺口，应鼓励更多社会资本流向 NbS 领域，促进公共和私人行动者采取行动，并保持密切协

调。

创新财税金融支持政策，营造社会资本参与的良好政策环境。探索基于碳汇权益的绿色信贷产品，发展森林碳汇债券、林业保险等绿色金融产品，促进林权抵押贷款、林票质押贷款等支持林业碳汇发展的绿色金融工具规范化应用。探索政府和社会资本合作（PPP）等模式，发挥政府投资的引导带动作用，并为参与企业提供相应税收优惠政策。探索林业碳金融普惠平台试点建设，创新多元化的个人碳产品，鼓励公众参与碳信用市场。

引导企业和金融机构完善规则标准，培育更多绿色投资者。引导国际金融机构、大型跨国公司完善净零目标的标准制定，考虑将碳信用纳入机构净零目标，丰富 ESG 评价指标体系。推动企业和金融机构减少对自然负面活动的融资，转变不可持续的商业模式，并加强信息披露。NbS 与中国生态文明理念高度契合，鼓励更多中资企业和外资企业探索 NbS 本地实施方案，对标 NbS 国际话语宣传有益经验做法，为相关政策体系奠定实践基础。

深化绿色金融国际合作，完善国际多边机制融资方案。进一步发挥央行与监管机构绿色金融网络（NGFS）、可持续金融国际平台（IPSF）等多边机制作用，将更多 NbS 项目纳入绿色金融目录，鼓励发展中国家探索适合各自国情的 NbS 路径和做法。对于 NbS 项目资金与应对气候变化和保护生物多样性资金边界模糊的问题，推动共同制定各多边议程下科学的融资计算方法，厘清发达国家参与 NbS 项目投资与减缓气候变化出资责任的关系^③。

中国国际发展知识中心“双碳”研究课题组

^③ 本报告属于必和必拓等合作伙伴支持的“碳达峰碳中和的中国战略与全球展望”旗舰研究交流项目成果。

International Progress in the Development of Ecosystem Carbon Sinks and Prospects in China

Center for International Knowledge on Development

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Abstract

Addressing climate change is a broad consensus reached by the international community. The function of carbon sequestration in ecosystems has major potential in adapting to climate change. Faced with escalating environmental challenges, countries around the world are increasingly taking nature-based solutions (NbS) as a holistic approach to collaboratively address multilateral agendas ranging from climate change to biodiversity loss. It is estimated that by 2030, the implementation of NbS in all ecosystems can remove at least 5-11.7 billion tons of carbon dioxide equivalent per year. Countries around the world, especially developed ones, have developed a series of management measures in the process of utilizing the carbon sink of ecosystems, and multinational corporations are also active in NbS investment. The demand for emission reductions from enterprises worldwide has continued to increase, driving the rapid growth in annual demand for global voluntary carbon credits, and an upward trend of the production of NbS carbon credits in forestry, agriculture, and land use. It is expected that the global voluntary carbon market will provide trading allowances of 2.6 billion tons of carbon dioxide equivalent per year in 2030.

China has made positive progress in improving the function of ecological carbon sinks. Giving full play to the ecological carbon sink function provides cost and technical advantages in achieving the “Dual Carbon” goals. In 2021, China issued the *Action Plan for Carbon Dioxide Peaking Before 2030*, and consolidating and enhancing carbon sink capacity of ecosystems was listed as one of the top ten actions for carbon peaking. At present, the total area of China’s woodlands, grasslands, and wetlands is 6.05 billion hectares and the forest and grassland coverage rate is 55.11%. The total carbon storage of forests and grasslands is 11.443 billion tons, and the annual carbon sink is 1.28 billion tons. China has improved its forest carbon sink function through three paths: increasing area, reducing losses, and improving quality. With “double growth” in both forest area and forest stock volume for 30 consecutive years, China has become the country with the fastest and largest growth in forest resources in the world. China has promoted the integrated

protection and restoration of mountains, rivers, forests, farmlands, lakes, grass and sand, and has created a large number of good practices with ecological, economic and social benefits, represented by Saihanba Forest Farm, turning lucid waters and lush mountains into mountains of gold and silver, and promoting climate change response, biodiversity conservation, and economic and social development. China has also actively cooperated with the international community to create demonstration cases for the world and jointly promote the mainstreaming of NbS. Going forward, China can consolidate and improve the carbon sink function of the ecosystem from three aspects to better achieve the “Dual Carbon” goals. First, China can optimize natural resource management policies and motivate business entities for production and operation relative to natural resources. The first is to give priority to the carbon sink value of state-owned forests by improving the management system of state-owned forest farms, and promote the effective protection and scientific utilization of forests. It can deepen the reform of the collective forest rights system, clarify the ownership relationship between forest property rights and forestry carbon sink property rights, and set up a reasonable benefit-sharing mechanism for carbon sink trading. The second is to optimize forest and grassland resource development policies, improve forest harvesting management, promote the moderate-scale management of forest land, improve the value realization mechanism of ecological products in the forest and grass industry, and improve sustainable operations. The third is to comprehensively increase scientific and technological support for the forest and grass industry, enhance forestry and grass industry mechanization, promote the development of large-diameter timber and high-quality grass, develop wood and bamboo processing, forestry biomass energy and other industries, and explore greater space for the diversified development of the forestry industry.

Second, China can improve the design of the carbon offset mechanism and create an internationally leading voluntary emission reduction market. The first is to accelerate the standardization of ecosystem MRV, apply satellite and other information technologies, improve regional-scale ground surveys, gradually align national ecological carbon sink accounting with international standards, and improve the credibility of the voluntary carbon credit market. The second is to strengthen the supervision and information disclosure of carbon sink projects, improve the disclosure standards for enterprises to participate in carbon offsets, strengthen the informatization of carbon sink projects, and introduce third-party assessment agencies to improve the transparency of the voluntary carbon market. The third is to encourage the Belt and Road countries to jointly build a large-scale voluntary carbon market with high transparency and high liquidity, form a stable price mechanism, and avoid potential market risks.

Third, China can fully mobilize non-governmental capital to support investment and financing of ecological carbon sink projects. The first is to introduce innovative

fiscal and financial support policies by developing bonds, insurance and other green financial products and financial instruments relative to forest and grass, and explore models such as public-private partnerships. The second is to guide enterprises and financial institutions to improve relevant rules and standards by considering incorporating carbon credits into the net-zero goals of the institutions, enriching the ESG evaluation system, and reducing financing for activities with a negative impact on nature. The third is to deepen international cooperation in green finance, include more NbS projects in the green finance catalog, encourage developing countries to explore NbS paths and practices suited to their respective national conditions, and clarify the relationship between the participation of developed countries in NbS project investments and their responsibility to finance climate change mitigation.

Addressing climate change is an international consensus. Under the *Paris Agreement*, countries have set emission reduction targets and implementation paths, not only to control carbon emissions in key sector such as energy, industry and transportation, but also to give full play to the role of ecosystems in reducing emissions and increasing sinks. As the cost of reducing remaining carbon emissions from high-emission sectors such as energy and industry becomes increasingly high, the ecological carbon sink function is considered to an indispensable and cost-effective means of carbon removal to achieve the “Dual Carbon” goals. Nature-based solutions (NbS) are regarded as the main measure to improve the carbon sink function of ecosystems and are an important part of the overall strategy and actions to achieve global climate change goals. They are important for carbon emission reduction, climate change risk reduction, and enhancing climate resilience.

1. International progress in leveraging the carbon sink function of ecosystems

The carbon sequestration in ecosystems has major potential in adapting to climate change. Land and oceans are sources of natural carbon sinks for Earth’s ecosystems. Terrestrial ecosystem carbon sinks are often called “green carbon”, of which forests dominate. Well-managed grasslands, wetlands, and soils can also become carbon sinks. Carbon captured by marine activities and marine organisms is often called “blue carbon”. NbS is a direct means to leverage the carbon sink function of the ecosystem. It can also be referred to as a supply-side measure. NbS refers to actions taken to protect, sustainably manage and restore natural or improved ecosystems to effectively and adaptively respond to social challenges and enhance human well-being and biodiversity gains. It is estimated that NbS projects implemented in all ecosystems could remove at least 5 billion tons of carbon dioxide equivalent per year by 2030, with a maximum estimate of 11.7 billion tons of carbon dioxide equivalent per year; this will rise by 2050 to at least 10 billion tons of carbon dioxide equivalent per year, with the highest estimate being 18 billion tons of carbon dioxide equivalent per year. About 62% of the contribution will come from forest-related solutions, and about 24% from grassland and farmland solutions. The basic idea of NbS mainly includes three aspects: first, protecting the ecosystem from conversion to other uses, which is also the top priority; second, addressing ecological degradation from the source or driving factors; third, restoring the ecosystem. Accordingly, there are three ways to increase sinks: The first is protective measures, that is, to prevent forestland, grasslands, wetlands, coastal wetlands, etc. from being converted into other uses. The second is management measures, including sustainable management of natural forests, fire management, and mixed agriculture and forestry operations, rotational grazing and conservation farming. The government can take measures such as providing subsidies, providing training and introducing land property rights reform to promote

the sustainable management of ecosystems. The third is restoration measures, such as afforestation and reforestation.

NbS have gradually become a holistic approach to global collaborative solutions to multilateral agendas such as climate change and biodiversity loss.

In 2008, the World Bank released the *Biodiversity, Climate Change and Adaptation: Nature-based Solutions from the World Bank Portfolio*, which for the first time proposed that NbS can be used as a new solution to protect biodiversity and improve sustainable livelihoods while mitigating and adapting to the effects of climate change. In 2009, the World Conservation Union (IUCN) proposed in its recommendation report submitted to the 15th Conference of the Parties of the United Nations Framework Convention on Climate Change that it would actively promote NbS as a key component of broader overall plans and strategies for climate change mitigation and adaptation, and further clarified the concept and content of NbS in 2016. In 2019, at the initiative of the United Nations Secretary-General, NbS was listed as one of the nine important global actions to address climate change by the United Nations Climate Change Conference. In 2023, the 28th Conference of the Parties to the United Nations Framework Convention on Climate Change reached the *UAE Consensus* to encourage the use of NbS and other methods to mitigate the impact of climate on ecosystems and biodiversity. In 2022, the total annual funds flowing to NbS reached USD 200 billion, a year-on-year increase of 11%, of which public finance accounted for 82% and private financing accounted for 18%. At the same time, every USD 1 million invested in NbS will create up to 40 jobs, which is almost 10 times the employment opportunities provided by investment in fossil fuels.

Countries around the world, especially developed ones, are actively leveraging the carbon sequestration potential of forests and other ecosystems. Major countries and regions are actively promoting the inclusion of NbS in national governance, climate action, and policy tools. In 2015, the European Union included NbS into the *Horizon 2020*, its official funding program for research and innovation. In 2022, the Biden administration released the *Nature-Based Solutions Roadmap* to guide the United States to fully unleash the potential of NbS and address climate change, natural loss, and inequality, and committed more than USD 25 billion in funding to support NbS implementation. *The USAID Climate Strategy 2022-2030* published by United States Agency for International Development emphasizes NbS as a key tool for carbon sequestration, reducing disaster risks, supporting livelihoods, and improving food and water security. Canada's first officially implemented *National Adaptation Strategy* specifically mentions the use of NbS to enhance climate resilience and maximize co-benefits. Multinational corporations are also active in NbS investment. In 2019, Australia's BHP Billiton announced that it plans to invest USD 400 million in the next five years to support the research, development and deployment of emission reduction technologies to reduce carbon

emissions in the group's operations and by downstream companies using BHP Billiton resources during production, and that it will drive investment in NbS. In 2022, BHP Billiton funded three blue carbon projects in Australia. It plans to provide more than AUD 5 million over three years to support marine emissions reductions.

A variety of voluntary emission reduction mechanisms have been established around the world to promote the quantitative certification and trading of ecological carbon sink effects. Carbon markets are mainly divided into three categories: the international carbon mechanism established under the *Kyoto Protocol* and the *Paris Agreement*, the locally established carbon mechanism, and the non-governmental independent carbon mechanism. International mainstream carbon mechanisms include the Clean Development Mechanism (CDM), Verified Carbon Standard (VCS), Gold Standard (GS), China's Certified Voluntary Emission Reduction Mechanism (CCER), American Carbon Register (ACR), and Climate Action Reserve (CAR), REDD+ Trading Framework (ART), and Global Carbon Council (GCC). Among them, the VCS is currently the largest independent carbon mechanism and the largest issuer of forest protection, sustainable management and forest carbon sink increase (REDD+) and forestry carbon credits. Most of the other carbon sinks participate in the voluntary emission reduction market through afforestation/reforestation. By voluntarily purchasing carbon credits, companies or organizations can offset unavoidable greenhouse gas emissions. As the demand for corporate emission reductions continues to increase globally, the global voluntary carbon market is developing very rapidly, driving the annual demand for global voluntary carbon credits to grow rapidly. According to the World Bank, the number of carbon credits issued by the world's three major carbon credit supply mechanisms in 2021 reached 478 million tons of carbon dioxide equivalent. The World Economic Forum states that by 2030, the global voluntary carbon market will provide carbon trading allowances of 2.6 billion tons of carbon dioxide equivalent per year. Currently, renewable energy projects are the main source of carbon credits. The generation of NbS carbon credits such as forestry, agriculture and land use is showing an upward trend, with 54% of new project registrations in 2022 being forestry and land use activities. In 2022, the global voluntary carbon market attracted USD 1.2 billion in investment. The U.S. Environmental Protection Agency predicts that the size of the global voluntary carbon market in 2030 is conservatively estimated to be between USD 5 billion and USD 30 billion, and may even reach USD 50 billion.

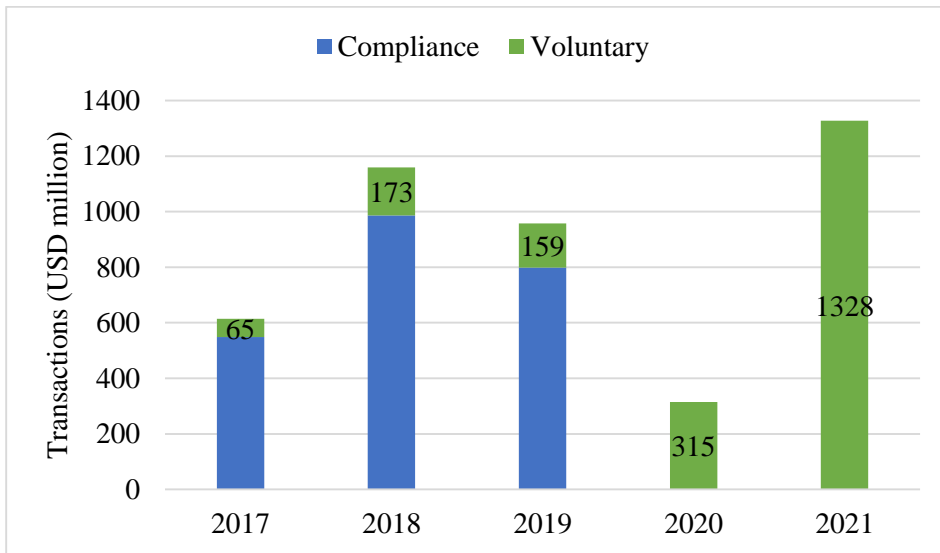


Figure 1 Forest-specific Voluntary and Compliance Carbon Market Transactions

Note: 1. Voluntary carbon market transaction values in the forestry and land use category.

2. The data for forest specific compliance markets includes value data for the New Zealand ETS, the Australian Emissions Reduction Fund, the Colombian Carbon Tax, the Korean ETS, the California-Quebec ETS, the Alberta ETS, the British ETS and the China sub-national ETS programs. It does not include other active ETS and compliance mechanisms, likely resulting in an underestimate for total global forest-based compliance transactions. No data is available for 2020 and 2021.

Source: Center for Global Development (2023)

2. China's practice in promoting the realization of carbon sink functions in ecosystem

China has kept improving the national greenhouse gas voluntary market with the China Certified Emission Reduction mechanism as the main body. The China Certified Emission Reduction (CCER) refers to the greenhouse gas emission reduction results in renewable energy, forestry carbon sinks, methane utilization and other projects in China that are quantitatively certified and registered in the national registration system for voluntary greenhouse gas emission reduction transactions. The China Certified Emission Reduction program is a supplementary mechanism to the compliance carbon market. Emission-control enterprises may purchase allowances or Certified Emission Reductions (CERs) to offset emissions

when their allowances are insufficient¹. In 2012, the National Development and Reform Commission (NDRC) promulgated the *Interim Measures for the Administration of Voluntary Greenhouse Gas Emission Reduction Trading* (the Interim Measures) and the *Guidelines for the Validation and Certification of Voluntary Greenhouse Gas Emission Reduction Projects*. Since 2013, the regional carbon trading pilots have been launched, creating a stable and large-scale demand for CCER by including the carbon offset mechanism in CCER projects. In 2017, as the NDRC initiated the revision of *the Interim Measures*, the registration and approval of CCER projects and the issuance of CERs were suspended, but the trading of the CCERs already registered was not affected. In 2023, the Ministry of Ecology and Environment (MEE) and the State Administration for Market Regulation (SAMR) jointly issued the *Administrative Measures for Voluntary Greenhouse Gas Emission Reduction Trading (for Trial Implementation)*. At the beginning of 2024, the national voluntary greenhouse gas emission reduction trading market was officially relaunched.

China has leveraged the cost and technical advantages of the ecological carbon sink function. Carbon sink supply is the basis for carbon sink market transactions. At present, the total area of China's woodlands, grasslands, and wetlands is 6.05 billion hectares, with a forest and grassland coverage rate of 55.11%. The total carbon storage of forests and grasslands is 11.443 billion tons, and the annual carbon sink is 1.28 billion tons. Specifically, forest resources have a big advantage in promoting the ecological carbon sink function. China has improved its forest carbon sink function through three paths: increasing area, reducing losses, and improving quality. In terms of area increase, China has increased a large amount of forests through afforestation projects such as the Three-North Shelterbelt Project, the Returning Farmland to Forest and Grassland Project, the Beijing-Tianjin Wind and Sandstorm Source Control Project, the forestry industry base construction project based on fast-growing and productive timber forests, and the National Reserve Forest Project. Among these projects, the Three-North Shelterbelt Project covers more than 95% of the sand-hazard areas and 40% of the water and soil erosion areas. In the past 40 years, the forest area in the project area has increased by 21.56 million hectares net, and the forest coverage rate has increased from 5.05% to 13.57%. The cumulative carbon sequestration has reached 2.31 billion tons of carbon dioxide equivalent, equivalent to 5.23% of the country's total industrial carbon dioxide emissions from 1980 to 2015. At present, China's forest area is 231 million hectares, with a stock volume of 19.493 billion cubic meters. With "double growth" in both forest area and forest stock volume for 30 consecutive years, China has become the country with the fastest and largest growth in forest resources in the

¹ In order not to discourage enterprises from reducing emissions, it is stipulated that the offset ratio shall not exceed 5% of the carbon emission allowances to be cleared.

world. It is estimated that in 2050, provided that the forest coverage rate increases from 24% to 28% and the stock volume per unit area stays at world average, China’s additional annual carbon sink capacity will reach about 1-1.5 billion tons of carbon dioxide equivalent. In terms of controlling reduction and degradation, China has reduced the number of forest fires, the number of casualties, and the amount of disaster-affected areas to historical lows through such projects and initiatives as natural forest protection projects, desertification prevention and control projects, building an integrated system for forest and grassland fire prevention and suppression, and forest and grass pest control projects. At the same time, China has also stepped up policies for the prevention and control of forest pests and diseases. In addition, China has effectively improved the resource quality of forests, grasslands, and wetlands through low-yield and low-efficiency forest rehabilitation projects, forest resource quality improvement projects, grassland reward and subsidy policies, and wetland protection and restoration projects, providing an effective supply of ecosystem carbon sinks.

Table 1 Main Indicators of Global Forest Resources

	Forest area (thousand hectares)	Forest cover rate (%)	Forest unit stock (m3/ha)	Carbon stock change per area (Mg C/ha/yr)
Worldwide	3999135	30.7	131	1.04
China	220446	22.96	94.83	1.22
New Zealand	10152	38.6	392	1.05
USA	310095	33.8	131	0.94
Germany	11419	32.8	321	1.68
Japan	24958	68.5	196.3	1.59

China has leveraged the ecological, economic and social co-benefits of Nature-based Solutions. In 2021, China issued the *Action Plan for Carbon Dioxide Peaking Before 2030*, listing consolidating and enhancing ecological carbon sink capacity as one of the top ten actions for carbon peaking. China pursues a holistic approach to the integrated protection and restoration of mountains, rivers, forests, farmland, lakes, grasslands and deserts, to improve the quality and stability of ecosystems, and enhance ecological carbon sinks. The implementation of the work focuses on three types of ecosystems: forests, grasslands and cultivated land, with a priority on protection and restoration measures, mainly including precise forest

quality improvement projects and cultivated land quality improvement actions, as well as other measures with multiple benefits such as returning farmland to forests. Measures to improve carbon sink capacity such as forest management can not only provide carbon sinks that generate ecological benefits, but can also increase the income of forest operators and create more jobs through the development of under-forest economy, forest health care, and forest tourism, thus achieving ecological, economic and social co-benefits and transforming lucid waters and lush mountains into mountains of gold and silver. This not only helps achieve the “Dual Carbon” goals, but is also of great significance for consolidating the results of poverty alleviation, achieving rural revitalization, and promoting common prosperity. Three generations of the Saihanba people have successfully created the world’s largest artificial forest with a total area of 1.12 million *mu* (or 74,667 hectares) and a forest coverage rate of 80%. The project generates an ecological service value of RMB 14.2 billion every year, delivers 137 million cubic meters of clean water to the Beijing-Tianjin area, and releases 570,600 tons of oxygen and sequesters 814,100 tons carbon dioxide, serving as an important ecological barrier guarding Beijing and Tianjin. At the same time, Saihanba National Forest Park receives more than 500,000 tourists every year, directly provides about 15,000 temporary jobs, and drives the development of such industries as rural tourism, special mountain products, handicrafts, and transportation in the surrounding regions, and generates a gross community income of more than RMB 600 million. The Bamboo Forest Carbon Sequestration Project in Anji, Zhejiang uses forest land management rights as pledge and applies for green loans from banks to address forestry financing difficulties. By establishing a whole chain system of “forest land transfer - carbon sink collection and storage - base management - platform transactions - return of profits”, it explores a “enterprise + cooperative + forester” business model and profit-sharing mechanism and takes full advantage of the short growth cycle and strong carbon sink capacity of bamboo forests to generate sustained and stable carbon sink benefits.

China has actively cooperated with the international community to jointly promote the mainstreaming of Nature-based Solutions. In 2019, the United Nations Climate Action Summit identified China and New Zealand as co-leads of the NbS Coalition to jointly release the outcomes of the coalition, including the *NbS for Climate Manifesto* and the *Compendium of Contributions Nature-Based Solutions - Climate Action Summit 2019*. In 2021, the Ministry of Natural Resources of China worked together with IUCN to jointly release the Chinese versions of the *IUCN Global Standard for Nature-Based Solutions* and the *Guidance for Using the IUCN Global Standard for Nature-Based Solutions*, and selected 10 representative cases nationwide in conjunction with China’s major projects and practices in ecological protection and restoration, including the Guanting Reservoir watershed management project, the Helan Mountain ecological protection and restoration

project, the Yunnan Fuxian Lake watershed management project, the Inner Mongolia Wuliangshuai watershed protection and restoration project, the Qiantang River source area protection and restoration project, the Jiangxi Wuyuan rural area construction project, the protective use of black soil in Heilongjiang, the urban renewal in Chongqing, the coordinated ecological restoration of land and sea in Beihai of Guangxi, and the mangrove wetland restoration in Shenzhen Bay, as a good demonstration and reference for NbS localization in China and around the world. In 2021, on the eve of the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change, China submitted its *Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy* to the UNFCCC Secretariat. In the strategy, China lists NbS as one of the ten strategic priorities and policy directions and proposes to actively leverage the potential of NbS in greenhouse gas emission reduction and sink enhancement, form a territorial spatial layout and ecosystem for emission reduction and sink enhancement, promote the green and low-carbon transformation of agriculture, and strengthen ecosystem protection and restoration and carbon storage. In May 2023, the Ministry of Natural Resources of China and IUCN signed an agreement to jointly establish the Nature-based Solutions Asian Hub, aiming to pursue sustainable development and ecological civilization, a notion embraced by the Chinese government that promotes harmonious coexistence of humanity with nature, through NbS research, practices and international cooperation.

3. China's future prospects for consolidating and improving the carbon sink function of ecosystems

As China's carbon emission reduction process advances, the technology potential for emission reduction narrows and emission reduction costs continue to rise. Nature-based Solutions can rely on ecological functions to increase carbon sinks to offset carbon emissions, which will help stimulate more efficient use of resources and promote synergies in addressing climate change, biodiversity conservation, economic and social development, reduce the social cost of carbon emission reduction, improve climate resilience, and contribute to carbon neutrality.

First, China can optimize natural resource management policies and stimulate the carbon sequestration potential of forest carbon sinks.

Currently, China has a large area of forests (the fifth in the world in area and sixth in storage), grasslands (the second in the world), and wetlands (the fourth in the world). Policies related to forestry and grassland resource management can be further improved to better balance the effective protection and scientific utilization of forest and grassland resources, achieve in a coordinated manner the high-quality development and high-level protection of the forest and grass industry, and unleash

more carbon sink space of forestry and grassland resources.

China can deepen the reform of property rights and systems in the forest and grass industry, and motivate forestry and grassland operating entities for production and operation. Given that the quality of forest resources in state-owned forests is higher than that of scattered collective forests², China may consider to give priority to the value of carbon sinks in state-owned forests, and improve the management system of state-owned forest areas and state-owned forest farms, set flexible fiscal policies, strengthen local government policy support for forestry operations, raise the budget for production and operating activities, formulate an incentive salary system, encourage the development of forestry carbon sink projects, and promote the effective implementation of forest protection and utilization policies. China can deepen the reform of the collective forest rights system and promote the separation of the collective forest land ownership, contract rights, and management rights. The ownership relationship between forest property rights and forestry carbon sink property rights should be clarified in legal form, and a reasonable carbon sink transaction benefit-sharing mechanism can be set up to protect the sharing of profits among operating entities.

China can optimize forest and grassland resource development policies and improve the value realization mechanism of ecological products. Forest harvesting limits can be reasonably opened up to meet the reasonable harvesting needs in forest management. New forestry operating entities and production bases can be cultivated and forest land can be managed on a moderate scale to make forest management more efficient and scientific. A sound ecological protection compensation mechanism that reflects the value of carbon sinks should be established and perfected to compensate both non-commercial forests and commercial forests for their positive externalities. Education and training on the development and utilization of ecological carbon sinks at the local level needs to be strengthened, and professional service organizations can be introduced and cultivated to avoid the potential risks and pitfalls of carbon sink projects. The system for managing forest ecological product labeling and product tracing need to be improved to create higher added value of forest products and enhance the sustainable management of forest and grass resources.

China can comprehensively increase scientific and technological support for the forest and grass industry and open up space for the diversified development of the forest industry. China can improve the mechanization of the forest and grass industry, promote the development of large-diameter timber and high-quality grass, give full play to the carbon sequestration, material substitution and energy

² According to the results of the Ninth National Forest Inventory, the stock volume of collective forests, which account for 61.34% of the national forest area, is equivalent to 68.51% of the stock volume of the state-owned forests.

substitution effects of woody forest products, create higher returns for the forest and grass industry, and achieve win-win outcomes for the economy and ecology. China can accelerate the development of green and low-carbon industries such as wood and bamboo processing and forestry biomass energy, promote the integration of modern forestry industry with other industries, and improve the entire industry chain of forest product processing and forestry resource development and utilization. It can encourage the research and development of new types of wood, develop timber frame construction, increase the diversified development of forest products, and effectively meet the market demand for various types of wood.

Second, China can improve the design of the carbon offset mechanism and create an internationally leading voluntary carbon market.

The voluntary emission reduction trading market is an important market mechanism to help countries and enterprises achieve carbon neutrality. It is an important tool to promote the deepening development of the carbon offset market and achieve low-cost emission reduction, with positive implications for encouraging the whole society to participate in emission reduction. Institutional mechanisms such as ecological carbon sink monitoring and accounting can be further improved, the credibility, transparency and connectivity of the carbon credit offset mechanism can be increased, and the activity and effectiveness of the voluntary emission reduction market can be enhanced.

China can accelerate the standardization of ecosystem MRV and improve the credibility of the voluntary carbon market. At the regional level, ecological carbon sink accounting should strive to be accurate, adopt a small regional scale, apply information technology such as satellites, and improve ground surveys to ensure the accuracy of basic data. At the national level, China can gradually align ecological carbon sink accounting with international standards, comply with IPCC accounting principles, and ensure that accounting results are internationally comparable. It can actively participate in the formulation of international standards for ecological carbon sink trading in various fields. Ecological carbon sink monitoring, reporting, and verification (MRV) at regional and national levels should be interconnected to ensure that carbon sink accounting results at different levels are harmonized to make carbon sink monitoring more reliable.

China can strengthen the supervision and information disclosure of carbon sink projects and improve the transparency of the voluntary carbon market. China can strengthen the guidance of regulatory agencies on the activities of the voluntary carbon markets, improve the monitoring of the entire process of corporate participation in carbon sequestration projects, improve the transparency of project implementation, and comprehensively improve the quality of carbon credit approval and verification. It can encourage companies to announce their voluntary

carbon trading status and improve the disclosure standards for corporate participation in carbon offsets to avoid the risk of corporate “greenwashing” and strengthen relevant supervision. It can establish a national carbon sink database for forests, grasslands, oceans and other ecosystems, strengthen the informatization of ecological carbon sink projects, and promote the sustainability of carbon sink development and trading. China can bring in third-party evaluation agencies to avoid distortions caused by companies’ self-evaluation and improve the fairness of transactions.

China can gradually promote the joint construction of a global voluntary carbon market and improve the connectivity of voluntary carbon markets. The construction of the international voluntary carbon market is in the ascendant, and China can seize the opportunity to participate in the formulation and improvement of relevant international rules and standards. It can encourage Belt and Road countries to jointly build a voluntary carbon market, optimize the scattered and small-scale status of the existing carbon offset mechanisms, facilitate the establishment of a large global voluntary carbon market with high transparency and high liquidity, and form a stable price mechanism in favour of developing countries and help developing countries avoid potential transaction risks in the carbon market. China can consider proposing a Voluntary Carbon Market Integrity Initiative to strengthen international cooperation in the field of climate change through a carbon credit mechanism and to increase its voice in the international climate arena.

Third, China can fully mobilize non-government capital to support investment and financing of ecological carbon sink projects.

Carbon sequestration projects in ecosystems, especially forests, will provide new forces for mitigating climate change and are a beneficial way to explore the harmonious development of man and nature. There is currently a huge funding gap in the climate field. China should encourage more non-government capital to flow to the NbS field, facilitate actions by public and private actors, and maintain close coordination.

China can innovate fiscal and financial support policies to create a sound policy environment for non-government capital participation. It can explore green credit products based on carbon sink equity, develop green financial products such as forest carbon sink bonds and forestry insurance, and promote the standardized application of green financial instruments that support the development of forestry carbon sinks, such as forest rights mortgage and forest ticket pledge loans. China can explore models such as public and private partnership (PPP), give full play to the guiding and driving role of government investment, and provide corresponding tax preferences for participating enterprises. It can explore the pilot construction of an inclusive platform for forestry carbon finance, innovate diversified personal carbon products, and encourage public participation in the carbon market.

China can guide enterprises and financial institutions to improve rules and standards and cultivate more green investors. China can guide international financial institutions and large multinational corporations to improve the standards development of net-zero goals, consider incorporating carbon credits into the institutions' net-zero goals, and enrich the ESG evaluation system. Businesses and financial institutions can be encouraged to reduce the financing of nature-negative activities, transform unsustainable business models, and enhance information disclosure. NbS is highly consistent with China's notion of ecological civilization. China should encourage more of its businesses and foreign-funded enterprises to explore local NbS implementation plans, benchmark international discourse on NbS and publicize useful experience and practices, and lay a practical foundation for relevant policy systems.

China can deepen international cooperation in green finance and improve financing plans for international multilateral mechanisms. China should further leverage the role of multilateral mechanisms such as the Network of Green Finance of Central Banks and Regulators (NGFS) and the International Platform for Sustainable Finance (IPSF), include more NbS projects in the green finance catalog, and encourage developing countries to explore NbS paths and practices suited to their respective national conditions. Regarding the blurred boundary between NbS project funds and funds to address climate change and protect biodiversity, China can promote the joint development of scientific financing calculation methods under various multilateral agendas and clarify the relationship between developed countries' participation in NbS project investments and their funding responsibilities for climate change mitigation³.

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