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——生物多样性保护与绿色发展
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月季 The China rose (*Rosa chinensis*)

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Guelder rose (*Viburnum opulus*)
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全球视野下的环境治理领域动态·2024年5月

【国内热点】

一、2024年淮河源生物多样性主题公众调查成果发布|5月22日国际生物多样性日

在国际生物多样性日来临之际，中国生物多样性保护与绿色发展基金会（简称中国绿发会，绿会）淮河源山水林保护项目组于2024年4月至5月期间，对桐柏县的生物多样性保护情况发起了一场公众调查。本次调查旨在了解桐柏县公众对生物多样性保护的认识、态度和行为，以及桐柏县在生物多样性保护和可持续利用方面的现状。通过收集和分析问卷数据，为桐柏县制定更加精准有效的生物多样性保护策略提供参考。

本次调查对象为桐柏县及周边县域居民，采用线上问卷形式进行，共收集到193份有效问卷。问卷内容涵盖了户籍地/常住地、年龄、性别、学历等基本信息，以及对生物多样性保护的认识、态度和行为等方面的问题。

本次调查结果表明，桐柏县居民对生物多样性保护具有较高的认识和积极的态度，但在具体知识和行动上仍存在差距，并据此提出了相应的建议。

详细调查成果可见：

https://mp.weixin.qq.com/s/XTeLWEFbJ9qjjDNeD4ky9g

二、探秘中国绿发会生物多样性科学馆

这里不仅是知识的殿堂，更是人与自然和谐共生的历史见证，这里没有都市的繁华，却承载着无数生态人对环境保护的执拗，这里没有金碧辉煌的穹顶，有的是生物多样性保护者们披星戴月走过的岁月痕迹……这里就是中国生物多样性保护与绿色发展基金会生物多样性科学馆。

现阶段，科学馆总共分为四个展区，分别是：历史专区、多媒体专区、物种专区、绿会保护地专区，每个展区都承载着丰富的历史故事和生态智慧。

中国生物多样性保护与绿色发展基金会生物多样性科学馆是一个集科普教育、生态体验、科学研究为一体的综合性场所。在这里，参观者可以更加深入地了解和学习生物多样性对人类社会的重要意义，为守护绿色地球贡献力量。

三、2024无锡蠡湖生态设计节：聆听设计与生态的对话

近年来，生物多样性丧失、气候变化、环境破坏成为全球共同面临的危机。如何通过设计，应对这些危机？生态设计理念的产生就是环境问题的严重性和可持续发展的需求。蠡湖生态设计节的举办，也希望通过生态设计来回应城市可持续发展中紧迫问题，让更多的人认识到生态设计的重要性，参与到城市可持续发展的实践中。这是全球范围内首次以生态设计为核心的国际性交流活动。

4月15日，蠡湖生态设计节在米兰设计周成功举办新闻发布会，并于5月17-19日在无锡蠡湖（渤公岛）正式举办，以“未来在水”为年度主题。本届设计节由无锡市文化旅游发展集团有限公司、无锡蠡湖未来城主办，中国生物多样性保护与绿色发展基金会（简称“中国绿发会”、“绿会”）、《生物多样性保护与绿色发展》科学期刊（简称《生绿》）联合国际生态经济协会、无锡市统战部、无锡市生态环境局、无锡市水利局、无锡城市发展研究中心等联合指导及支持。

满满生态元素的五场装置艺术主题展览，随着5月17日无锡蠡湖生态设计节的开幕，与公众零距离见面。这些艺术设计作品，以“生态环境保护”为出发点，强调对自然环境的尊重和保护，即在设计过程中优先考虑自然环境的因素，如地形、气候、生物多样性等，为回应城市可持续发展中紧迫问题，探索人与自然和谐共生的解决方案。


左图：绿会副秘书长熊昱彤的《行走三境》生态摄影展。

右图：艺术家黄飞春先生的《Give Me Five！》人熊的互动设计

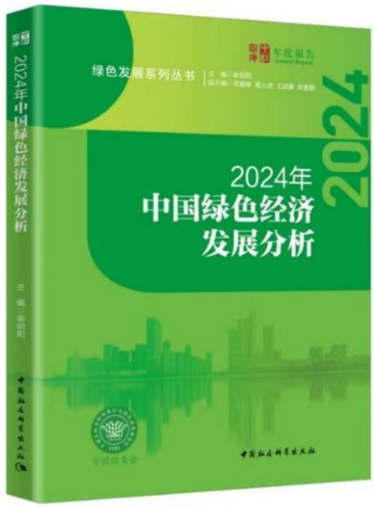

左图：建筑师俞挺设计的“翠屏花障”

右图：建筑师张文博设计的“境园”（公共卫生间）

四、《2024 年中国绿色经济发展分析》正式出版

日前，由中国生物多样性保护与绿色发展基金会（简称“中国绿发会”、“绿会”）组织编写的《2024 年中国绿色经济发展分析》（简称绿皮书）已经全面完成编撰工作，由中国社会科学出版社出版，2024 年 3 月第一版，2024 年 3 月第一次印刷，目前已上市发行。今年的绿皮书由胡昭广、谢伯阳、周晋峰同志分别作序，绿皮书课题组执笔撰写：“践行绿色发展建设美丽中国”的总报告，介绍了中国对绿色发展做出的大国担当与全球贡献。

绿皮书就理论探索与战略研究、绿色规划设计、绿色能源、绿色供应链金融、推行绿色生产方式、绿色经济循环、智能创新发展、绿色经济的实践活动、绿色消费等方面组织了相关领域的专家学者撰写了三十几篇高质量的绿色经济发展的专业文章，最后还附录了十个社会经济发展的典型案例。



【国际视野】

一、《2024年世界野生动植物犯罪报告》发布

2024年5月13日，联合国毒品和犯罪问题办公室（UNODC）在奥地利维也纳发布了《2024年世界野生动植物犯罪报告》（World Wildlife Crime Report 2024）。这是继2020年和2016年两份报告之后的第三份系列报告。

图源：联合国毒品与犯罪办公室

报告探讨了非法贩运《濒危野生动植物种国际贸易公约》（CITES）所列野生动植物物种的最新趋势，并对目前有关全球一级相关犯罪的原因和影响的知识进行了广泛评估。与2016年和2020年发布的前两版报告一样，第三版报告的研究包括对全球野生动植物贩运的定量评估和一系

列深入的案例研究。该版本的另一个重点是系统分析野生动指物犯罪的危害和影响、推动犯罪趋势的因素，并对目前为解决野生动植物犯罪而采取的不同干预措施的有效性进行了评估。

报告将新的重点放在评估全球野生动植物贩运和相关犯罪的原因和影响上。报告的调查结果强调了一个重要信息，即不同的非法野生动植物商品部门之间，从源头到终端市场的贩运因素差异很大。报告强调了使用可量身定制的解决方案的重要性，以及正在进行的野生动植物犯罪研究的潜力，通过深入了解犯罪结构、财政激励和贩运链不断变化的需求模式来协助这些努力。

报告的结论是，尽管在国际和国家层面采取了二十年的协调行动，但野生动植物贩运在世界范围内仍然存在。有迹象表明，在减少对一些标志性物种（大象和犀牛）的贩运影响方面取得了进展，需求方和供给方的共同努力已取得积极成果。然而，毒品和犯罪问题办公室对现有证据的评估表明，野生动植物贩运总体上正在大幅减少。

报告原文请参见：

https://www.unodc.org/documents/data-and-analysis/wildlife/2024/Wildlife2024_Final.pdf

二、世界艺术与科学院第六十四届大会开幕！

2024 年 5 月 15 日，世界艺术与科学院（WAAS）第六十四届大会在线召开。会议将有助于建立一个方案和活动框架，以支持联合国可持续发展目标、人人享有和平与人类安全。中国生物多样性保护与绿色发展基金会副理事长兼秘书长、世界艺术与科学院院士周晋峰博士受邀参加，并将在 6 月 26 日召开的世界艺术与科学院“支持人类安全和可持续发展的科学外交”（Science Diplomacy to support Human Security & Sustainable Development）会议上发表演讲。

在开幕式上，各位嘉宾分别就三个问题分享了自己的看法：您对人类当前面临的最大和最重要的悬而未决的问题的看法；考虑到那些悬而未决的重大问题，必须解决哪些基本问题，以便我们能够提出正确的解决方案；您认为诸如过去和其他机构之类的机构在解决这些问题方面可以发挥什么作用。

参会嘉宾包括第 73 届联合国大会主席、世界艺术与科学院院士玛丽亚 •埃斯皮诺萨（Mar í a ESPINOSA），联合国教科文组织社会与人文科学部门社会政策司司长古斯塔沃 •梅里诺（Gustavo MERINO），世界艺术与科学学院院长兼首席执行官加里 •雅各布斯（Garry JACOBS）等。

三、绿会代表团将赴德国波恩参加UNFCCC 附属机构第六十届会议

《联合国气候变化框架公约》附属科学技术咨询机构和附属履行机构第六十届会议（the sixtieth sessions of the Subsidiary Body for Scientific and Technological Advice and the Subsidiary Body for Implementation, SB 60）将于 2024 年 6 月 3 日至 13 日在德国波恩世界会议中心召开。

中国生物多样性保护与绿色发展基金会（简称中国绿发会、绿会）是《联合国气候变化框架公约》（UNFCCC）的观察员机构。为积极贡献全球气候治理，绿会气候变化工作组已组建参会代表团，将于今年 6 月赴德国波恩现场参加会议。

本次会议鼓励女性、青年和发展中国家代表参与，并将成为于 2024 年 11 月阿塞拜疆巴库召开《联合国气候变化框架公约》第二十九次缔约方大会（COP29）前的重要节点和里程碑。

本期聚焦：外来入侵物种与生物多样性

生物多样性对于支持地球上所有生命的过程至关重要，支撑着人类现在和未来的福祉。人类以多种方式依赖生物多样性。据估计，鸟类、蜜蜂和其他昆虫等传粉媒介贡献了全球三分之一的农作物产量。农业还依赖无脊椎动物，它们有助于保持农作物生长所需的土壤健康。土壤中的微生物对释放植物生长所需的营养物质至关重要，而这些营养物质通过食物链最终传递给我们……因此保护生物多样性对我们有着重要意义。

在过去的几十年中，科学研究广泛记录了人为引起的全球变化对生物群落、人类健康和经济的负面影响。越来越多的研究证明，全球变化因素并不是独立作用的，而是以复杂的相互作用交织在一起。例如，入侵物种的扩散已成为人类世的一个破坏性标志，在全球化贸易和旅行的推动下，入侵物种迅速在城市化的入境口岸扎根，污染和退化的环境又进一步促进了它们的传播。在这种背景下，不仅需要对促成入侵成功的特征进行研究并据此提出潜在的监管机制，还必须将这些机制置于更广泛的全球变化框架内进行考量并转化为实际行动。

2023年12月19日，在《昆明-蒙特利尔全球生物多样性框架》通过一周年之际，联合国《生物多样性公约》（CBD）秘书处发起了“生物多样性计划”活动，旨在向全世界宣传和推广该框架的4项长期目标和23项具体目标。其中，2030年内要实现的23个具体目标中，就包括防止引入重点外来入侵物种，将其他已知或潜在外来入侵物种的引入和定居率至少减少一半等。2024年5月22日是第24个国际生物多样性日，主题是“参与部分计划（Be part of the Plan）”。

本月期刊重点聚焦“外来入侵物种与生物多样性”系列议题，并与广大读者共同探讨外来入侵物种的危害以及可行的应对之策。

外来物种入侵的危害与应对策略研究

韦琦　杨洪兰

摘要：生态安全与政治安全、军事安全和经济安全一样，都是事关大局、对国家安全具有重大影响的安全领域。外来物种入侵对全球生态已构成重大威胁，因此外来物种入侵研究是生态安全领域研究的重要方面。本文针对外来物种入侵的危害进行了深入探讨，同时提出了有效的应对策略。通过分析外来物种入侵对生物多样性、生态环境和人类健康等产生的负面影响，并从监测预警、国际合作、宣传教育、生物控制和物种管理等方面，提出应对策略，以期能为生态安全规划和部署提供一定参考。

关键词：外来物种入侵，生物多样性，生态安全

韦琦，杨洪兰.外来物种入侵的危害与应对策略研究.生物多样性保护与绿色发展.第1卷，2024年5月，总第61期.ISSN2749-9065

随着经济全球化进程的不断加速，外来入侵物种已成为全球需要共同面对的重大生态安全问题之一。控制外来物种入侵作为昆明-蒙特利尔全球生物多样性框架的核心目标之一，对支撑至少有效恢复30%的生态系统等具体指标的实现意义重大。《自然》杂志2021年公布的研究数据显示，1970年至2017年间全球生物入侵造成的经济损失累计约1.288万亿美元，年均268亿美元[1]。中国作为世界上生物多样性最丰富的国家之一，也是受外来物种入侵影响最严重的国家之一。截至2019年，入侵我国的外来物种已超2000种，造成重大经济损失的物种超过700种。2000年以来，中国每年新发、突发的外来入侵物种有5到6种，并且传入速度还在不断加快。随着全球化进程的加速，入侵物种扩散蔓延大有加剧恶化之势，严重威胁我国生态安全，严重影响区域经济发展与可持续发展。入侵物种通过竞争、捕食、疾病传播等方式，对本地生物多样性和生态系统产生了深远影响。因此，探讨外来物种入侵的危害及应对策略，对于保护中国的生物多样性和生态环境具有重要意义。目前，我国外来入侵物种防控还是以被动性防控为主，主要采用检测后处理或监测后治理，绝大多数处理手段都是被动性防控[2]。探讨不同时间节点上的应对策略是本研究的重点内容，精准系统的应对策略对我国外来入侵物种防控具有重要作用。

一、外来物种入侵的危害

（一）威胁当地生物多样性

外来入侵物种可能会破坏当地的生态平衡，威胁当地的生物多样性。外来入侵物种通过占据本地物种的生态位，排挤本地种，改变种群、群落或生态系统的结构和功能，导致生态系统的单一或退化，并直接或间接影响本地种的遗传多样性。具体威胁如下：

1. 生态位竞争加剧

外来物种进入新环境后，可能会占据与本地物种相似的生态位，导致资源（如食物、栖息地、水分等）的竞争加剧。这种竞争可能使本地物种无法获得足够的资源以维持其种群数量，从而导致其种群数量下降甚至灭绝。以加拿大一枝黄花为例，加拿大一枝黄花作为我国重点管理的外来入侵物种，原产于北美，1935 年作为观赏植物引进我国，20 世纪 80 年代扩散蔓延成为杂草。目前在浙江、上海、安徽、湖北、湖南、江苏、江西等地已对生态系统形成威胁。该花繁殖和生长能力极强，一株一年能生产两万粒以上的种子，随风飘到哪里长到哪里，缺乏天敌制约，适应性很强，严重压缩本地植物、农作物生存空间，导致资源竞争加剧。

2. 捕食与被捕食关系改变

外来物种可能会成为本地物种的新捕食者，或者成为本地捕食者的新猎物。当外来物种作为捕食者时，它们可能大量捕食本地物种的幼体或成年个体，导致本地物种种群数量减少。这样的例子有很多，以入侵新西兰、澳大利亚的物种亚洲桨蟹为例，亚洲桨蟹原是亚洲中部及东部的原生物种，亚洲桨蟹体积不大，攻击性极强，对当地水中的海洋生物构成严重威胁。不仅与当地螃蟹（如：兰花蟹）竞争，还可吞食海湾中的各种贝类和其他软体动物，直接改变了当地捕食与被捕食关系，威胁当地生物[3]。当外来物种作为被捕食者时，它们可能会消耗大量捕食者资源，降低本地物种被捕食的压力，影响生态系统平衡。

3. 疾病与寄生虫传播

外来物种可能携带新的病原体或寄生虫，对本地物种构成威胁。本地物种可能因缺乏对新病原体的抵抗力而大量死亡，从而破坏生态平衡。以非洲大蜗牛为例，非洲大蜗牛是我国首批 16 种外来入侵物种之一，也是中国国家进出境二类检疫性有害生物，是许多人畜寄生虫和病原菌的中间宿主。

4. 遗传侵蚀

外来物种与本地物种之间的杂交和基因渐渗可能直接导致遗传侵蚀[4]。杂交后代可能不具备本地物种的适应性特征，从而降低其生存能力。此外，杂交还可能导致本地物种基因库的污染，使其逐渐失去原有的遗传特性。例如中国大豆，中国是大豆的起源地和品种多样性集中地，有6000多份野生大豆品种，占全球的90%以上，近些年来，随着转基因技术的兴起，转基因大豆悄然种植，如果种植转基因大豆外溢，野生大豆基因受到污染，中国大豆的遗传多样性也会丧失，其损失不可限量[5]。除杂交和基因渐渗导致的直接影响外，外来入侵物种对基因多样性的影响也可以是间接的，如通过改变自然选择模式或本地种种群内或种群间的基因交流[6]。

5. 生物群落结构改变

外来物种入侵可能改变生物群落的结构和功能。一些关键物种的消失可能导致生物群落崩溃，进而影响整个生态系统的稳定性和功能。此外，外来物种可能通过占据新的生态位、改变食物链和营养级结构等方式，对整个生态系统产生深远的影响。以入侵我国的鳄雀鳝为例，鳄雀鳝原产于美洲，性格凶猛，在水中无天敌，进入养殖水域会捕食养殖种，进入自然水域改变生物群落的结构和功能，严重影响本土种生存。

6. 经济与生态服务损失

外来物种入侵可能导致当地生态系统的经济价值下降。例如，渔业、农业和旅游业等产业可能因生态系统破坏而受损。此外，外来物种还可能破坏土壤结构、水质和空气质量等生态服务，对人类生活产生负面影响。以入侵我国的水葫芦为例，水葫芦又叫凤眼蓝、水浮莲，是一种原产南美洲的水面浮生植物。水葫芦根系发达，会迅速繁殖，到一定的数量时会限制水体的流动，同时还会覆盖水面，导致水体会因为无法受到阳光的照射而发臭，水葫芦会减少水中的溶氧含量并抑制浮游生物的生长，导致水下的动物（如鱼类）会因为难以呼吸而出现大量死亡的现象，而死亡的动物腐烂后会严重污染水质，会对环境、运输、水产养殖、旅游等造成严重经济损失[7]。

7. 生物入侵的累积效应

外来物种入侵的危害往往具有累积效应。随着时间的推移，外来物种可能逐渐适应新环境并扩散到更广泛的区域。以入侵我国的红火蚁为例，红火蚁原产于南美洲的巴西、巴拉圭和阿根廷的巴拉那河流域，2016

年，红火蚁入侵了我国11个省份的281个县。然而，到了2023年，这一数字已跃升至12个省份的625个县，短短7年内新入侵了344个县市区，其扩散速度之快令人咋舌[8]。红火蚁入侵具有明显累积效应。此外，一些入侵物种可能与其他外来物种相互作用，形成复杂的生物入侵网络，进一步加剧对生物多样性的破坏。

（二）破坏生态环境，威胁农业生产

外来入侵物种造成的农业损失是不可估量的，以薇甘菊为例，薇甘菊被称为“生态杀手”，一旦扩散开来，就能迅速覆盖农田，导致农作物无法生长，1株薇甘菊就能毁掉1亩农田，给农民带来了巨大的经济损失[9]。除此之外，像福寿螺、烟粉虱等等，这些外来入侵物种会直接导致农作物减产、质量下降，严重威胁我国粮食安全。

（三）危害人类健康

外来入侵物种除了会对生态环境造成危害外，某些外来物种，还可能会严重威胁人类健康，例如我们熟知的杀人蜂，还有引发人类的过敏反应的豚草等植物的花粉[10]。

二、应对策略研究

外来物种入侵的危害是显而易见的，防控就显得至关重要。一般而言，由于入侵物种的源头都是在境外，通常防控上采取以防为主，以治为辅的策略。要实现精准防控，可以在防控策略上下功夫，采取全流程的精准防控策略，主动出击，防控并存。具体如下：

（一）源头：建立完善的监测预警机制

入侵源头是外来物种的发源地，也是入侵全程防控最易被忽略的部分和最难防控的环节。但随着外来入侵物种的不断扩散，很多已经被侵入定殖的区域会转换为新的外来物种入侵源头，即发生桥头堡效应[11]。例如草地贪夜蛾原产于美洲，2016年入侵非洲，进一步以非洲为桥头堡入侵亚洲，2018年传入印度和斯里兰卡等亚洲国家，之后以南亚为桥头堡在2019年传入中国[12]。基于此，源头管理上，应建立完善的监测预警机制，主动出击，及时了解外来物种的入侵的新动向、新情况，对高风险物种进行重点监测和预警，建立名目和清单，建立地区分区管理制度。此外，对预警重点地区中的进口品进行清单重点检疫。

（二）过程控制：建立应急响应机制

对于已经外溢的高风险外来入侵物种，则需要建立应急响应机制，尽快降低入侵物种种群密度，防止快

速繁殖。应建立高效、精准、严密的入侵物种防控体系，建立最严格的目标责任清单和响应机制。

（三）后期：联防联控、信息共享

对于已经大量外溢的高风险外来入侵物种，并在入侵地区长久生存，将其从生态系统中完全移除已经是不太可能实现的，应该建立联防联控机制，对外发布，实现信息共享，最大限度的延缓和防止区域二次外溢，最大可能地将其防控在一个固定区域，并降低其对环境的影响。探讨通过生物控制等方法，如引入天敌等，研究入侵物种控制的方法和补救措施。同时，应加强国际合作，加强宣传和教育。

三、结论

外来物种入侵对生物多样性、生态环境和人类健康构成了严重威胁。因此，我们应该采取一系列的综合措施来应对这一问题。在源头方面，应该建立完善的监测预警机制，在过程控制中，应该建立应急响应机制，在后期防控，应该建立联防联控机制、实现信息共享。当前，传统生物安全问题和新型生物安全风险相互叠加，境外生物威胁不断加剧，很多入侵物种表现出新的特点，这要求我国不断提升生物入侵防控策略，以主动、系统、精准、高效地防范外来生物入侵。

但需要注意的是，很多地方对于外来入侵物种通常采用“一刀切”的做法，动辄开展全民扑杀运动，恨不得将外来入侵物种彻底赶尽杀绝。总体来说，对于外来入侵物种，如果它不影响我们的生产和生活，不会给生态环境带来负面的影响，我们都应该“让自然、给自然、以自然”，亦即“你别管它”，让它自然地淘汰、进化和演化，自然地生存发展就好[13]。

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中国原生鲑科鱼类和鲑鱼养殖业中外来种

温波

摘要：中国原生的鲑科鱼类约有14种。东北地区河流中的太平洋鲑鱼种群数量锐减。陆封型鲑科鱼类在大陆有川陕哲罗鲑、秦岭细鳞鲑；台湾地区有樱花钩吻鲑，均为濒危物种。新疆北鲑、石川哲罗鲑等跨境物种亟待国际合作保护。鲑鱼养殖场大量引进外来鲑科鱼类繁育饲养，需要关注对当地河流、湖泊和海洋等原有生态系统的影响。

关键词： 原生鲑科鱼类，鲑鱼养殖，外来种

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导言

鲑鱼是鲑科多种鱼类的俗称。鲑鱼生活在高纬度的海洋或高海拔的寒冷河水中。它们是典型的洄游鱼类，幼鲑鱼在春季游向大海，成年鲑鱼在秋季返回河流产卵。一部分鲑鱼是陆封物种。

几十年前，大西洋鲑鱼经香港传入广东。英文“salmon”在广东话中发音为“三文”，随后该称呼传遍了全国。因此，三文鱼最初仅指大西洋鲑鱼，现在则包括太平洋鲑鱼和鳟鱼等多种鲑鱼品种。

现今，大部分进口三文鱼来自挪威和智利。随着市场的爆炸性增长和供不应求，许多其他鲑鱼和鳟鱼也被归类为三文鱼，并以不同的子类别进行销售。广义而言，虽然市场上有养殖三文鱼和野生三文鱼，它们生活在不同的水域，有不同的外观和肉色，但在中国都被视为三文鱼。因此，三文鱼一词更多的是一个商业概念，而非严格意义上的科学概念。

在东北地区，太平洋鲑鱼被称为大马哈鱼。该名称源自黑龙江省的赫哲语。

一、中国的原有野生鲑鱼种类

中国的鲑科鱼类约有14种，占世界鲑科鱼类的20%以上，包括马苏鲑（Masu salmon）（含陆封性）、驼背鲑（Pink salmon）、狗鲑（Chum Salmon）、石川哲罗鲑（Korean taimen）、哲罗鲑（Siberian taimen）、川陕哲罗鲑（Sichuan taimen）、细鳞鲑（Lenok）、白斑红点鲑（Mountain trout）、花羔红点鲑（Dolly Varden）、北鲑（Inconnu）、乌苏里白鲑（Amur whitefish）、卡达白鲑（Khadary whitefish）以及虹鳟、河鳟等，其中虹鳟的放流量最大。

（一）东北地区的太平洋鲑鱼

在中国东北部流入太平洋的河流中发现了三种太平洋鲑鱼，即马苏鲑（*Oncorhynchus masou*）、驼背鲑（*Oncorhynchus gorbuscha*）和狗鲑（*Oncorhynchus keta*）。历史上这些太平洋鲑鱼在中国的产卵场包括黑龙江、乌苏里江、绥芬河、松花江、牡丹江和图们江，其中松花江和牡丹江的溯河种群已多年未见。

马苏鲑在黑龙江的乌苏里江中数量最多，在图们江、珲春江、密江、绥芬河和嫩江中也能发现，在台湾的大甲溪中还有一个内陆亚种，被称为樱花钩吻鲑。1976 年，在黄海海域也发现了其少量个体。

秋季洄游到抚远县的太平洋鲑鱼从鄂霍次克海出发，经过俄罗斯境内的黑龙江，于每年 9 月上中旬至 10 月下旬洄游到中国。在抚远县，鲑鱼按照地域有黑龙江鲑鱼和乌苏里江鲑鱼之分。黑龙江、乌苏里江和松花江的自然保护区内都有太平洋鲑鱼的产卵场。然而，多年来抚远县的过度捕捞导致这些鲑鱼数量下降。此外，抚远县的太平洋鲑鱼体型变小，成熟年龄也趋于年轻化。

近年来，在中国分布的太平洋鲑鱼，其种群呈明显下降趋势，主要因素是过度捕捞、水坝工程和河流污染。根据文献记载，历史上的东北地区太平洋鲑鱼捕捞量为：1947-1949 年平均收获量为 30.6 万尾；1950-1969 年为 37.2 万尾；1970-1979 年为 18.8 万尾；1980-1989 年为 21.4 万尾；1990-1999 年平均收获量为 4.5 万尾。2000 年至 2004 年，平均捕获量仅为 19000 尾。

图们江的鲑鱼资源曾经非常丰富，但后来由于渔业生态系统恶化、江水污染和无节制的过度捕捞，鱼类资源崩溃，鲑鱼产量下降到原来的十分之一。2004 年，对乌苏里江鲑鱼繁殖种群的结构特征数据进行的研究结果显示，该种群的个体长度和重量比过去明显变小。目前该种群濒临灭绝，亟需保护。

（二）川陕哲罗鲑

川陕哲罗鲑（*Hucho bleekeri*）是中国长江流域的特有物种，分布于四川省的长江上游支流、四川省和青海省的大渡河中上游以及陕西省秦岭以南的汉江上游和支流。它主要生活在水流湍急、底质为沙质和砾质的溪流中。由于栖息地的丧失和非法捕捞，这一特殊鱼类种群受到严重威胁，被世界自然保护联盟（IUCN）列为“极度濒危”物种。

（三）细鳞鲑

细鳞鲑属的种和亚种在科学上仍无定论。在1930年发现，并被命名为图们江细鳞鲑（*Brachymystax tumensis*）。1966年，李思忠以指名细鳞鲑的秦岭亚种命名秦岭细鳞鲑（*Brachymystax tsinlingensis*）。但这种细鳞鲑在中国古代就被当时人们发现，并捕获作为贡鱼提供给皇家。其主要分布于秦岭两侧渭河上游及其支流及汉水北侧支流湑水河、子午河上游的溪流中。秦岭细鳞鲑和川陕哲罗鲑一样，都是典型的第四纪冰川陆封残留冷水性鱼类。目前在陕西省和甘肃省都设有保护秦岭细鳞鲑自然保护区。

（四）新疆北鲑

北鲑（*Stenodus leucichthys*）主要在中国分布于新疆额尔齐斯河干流下游。新疆的额尔齐斯河、布尔津河等均有分布。1960年代初由于过度捕捞此鱼，其后产量逐渐下降。1980年代则极其罕见，几乎濒临绝迹。导致这种局面有两个原因：其一额尔齐斯河近年一直处于枯水年，水量少，特别是产卵的秋季；二是哈萨克农业灌溉，在额尔齐斯河中下游开辟一条引水渠，导致流入鄂毕河（即额尔齐斯河）的水源减少，鱼类无法溯河产卵。

（五）花羔红点鲑

花羔红点鲑（*Salvelinus malma Walbaum*），鲑科红点鲑属鱼类动物，有陆封型和洄游型之分，中国境内为陆封型，终身生活于江河干流及支流清冷水域，每年9至10月份，水温8摄氏度左右时，在砾石底质、水深30至60厘米的缓流处产卵。分布于鸭绿江、图们江、绥芬河水系的上游支流。是栖息山涧溪流的中小型冷水性稀有鱼类。

（六）石川哲罗鲑

石川哲罗鲑（*Hucho ishikawae*）在中国仅见于鸭绿江上游及其山涧，是吉林省的特有物种。随着当地大幅发展工业、农业、渔业等，鲑科鱼类在其捕捞量中占比达到80%。随着人口增加，水利工程建造、污水排放、渔具更新，石川哲罗鲑大受打击。1980-1984年吉林全省的大规模鱼类调查仅采集到14尾石川哲罗鲑，1994-1997年鸭绿江上游支流采集到的石川哲罗鲑仅有2尾，随后中国再无记录到石川哲罗鲑，有可能已经在中国灭绝。虽然有学者在1990年代就提出过进行人工繁殖并且建立增殖放流站，用于保护这类冷水鱼类的吉林鸭绿江上游国家自然保护区也在后续建起，但为时已晚。

（七）樱花钩吻鲑

樱花钩吻鲑又称台湾鲑鱼，是马苏鲑（*Oncorhynchus masou*）最南端的亚种。台湾鲑鱼是世界上最稀有的鱼类之一，种群数量正处于灭绝边缘。其曾是台湾原住民的食物，但过度捕捞和水坝导致其数量减少，据官方统计，到 1992 年仅存 200 条。现在，其原生栖息地得到保护，通过有效的保育努力，使鱼群数量在 2020 年恢复到 12587 条。2023 年 3 月，雪霸国家公园管理处统计的樱花钩吻鲑数量达到 15374 条，再次刷新自 1995 年复育以来的新高。台湾中央银行所发行的新台币 2000 元钞票，背面就印有樱花钩吻鲑。

二、中国鲑鱼养殖和外来物种引进

鲑鱼养殖场的分布在中国东北、新疆、青藏高原和云贵高原地区，黄渤海也有鲑鱼养殖的情形。此外，在浙江宁波市象山县高塘岛，丹麦企业投资建有陆基三文鱼循环水系统大西洋鲑养殖基地，为国内首家外资鲑鱼养殖场。

（一）东北地区

哲罗鲑生活在中国和其它东北亚国家。它也被称为“水中的西伯利亚虎”，是 IUCN 红色名录中的易危物种。分布于中国、哈萨克斯坦、蒙古和俄罗斯。在中国分布于黑龙江和嫩江上游、牡丹江、乌苏里江、松花江、镜泊湖和额尔齐斯河。2005 年，黑龙江省水产研究所渤海冷水鱼试验站成功进行了人工繁殖，获得了人工驯化鱼苗。

2003 年，位于黑龙江省五大连池市的山口水库从新疆的赛里木湖引进了 42.5 万尾源自俄罗斯的高白鲑（*Coregonus peled*）的鱼苗，2006 年又再次引进赛里木湖鱼苗。

（二）新疆

新疆额尔齐斯河干流下游有北鲑分布，但新疆至今没有养殖该鱼种。四川的养殖场有北鲑鱼种。

自 20 世纪 70 年代以来，伊犁河流域已有 40 多年养殖虹鳟鱼的历史。新疆伊犁尼勒克县位于伊犁河上游，已有三座大中型水库。库区水温常年保持在 8-13 摄氏度，水质清澈，适宜冷水鱼的生长繁殖和规模化养殖。2014 年伊始，在尼勒克县海拔 1000 多米的天山冰川活水水域建有三文鱼养殖基地，开启新疆内陆大水面三文鱼养殖。

1998 年，新疆的赛里木湖首次引入了俄罗斯的高白鲑和秋白鲑（*Coregonus autumnalis*），如今已经适应当地生存环境。

（三）青藏高原

中国央视财经报道称，中国国内市场上三分之一的鲑鱼来自青藏高原，产自黄河上游青海省共和县境内的龙羊峡，这里有中国目前海拔最高、规模最大的鲑鱼养殖场。

青海省：2003 年，青海省从俄罗斯引进高白鲑等鱼种，在龙羊峡、黑泉、南门峡等水域增殖。青海省积极引导黄河流域群众在龙羊峡、李家峡、公伯峡等水库开展网箱养殖。青海省首次成为国内最大的高白鲑鱼产区。同时，青海大力开展高白鲑育苗，在大通、南门峡等地建立了三个高白鲑苗基地和一个养殖基地，累计向新疆、黑龙江等供应高白鲑苗近 500 万尾。

西藏自治区：帕里玛曲河位于喜马拉雅山脉中段南麓的西藏日喀则亚东县境内，栖息着亚东鲑。现为西藏二级保护动物。19 世纪后半叶，英国人从欧洲将其引入喜马拉雅山南麓。先引入印度北部，后被引入西藏亚东地区。

亚东鲑是日喀则三宝之一。亚东县生态产业园三文鱼养殖基地投资 2.4217 亿元，包括养殖池塘、孵化育苗车间、生态循环健康养殖区等。在当地政府的引导下，农牧民开始尝试养殖亚东鲑。

（四）云贵高原

四川省都江堰市龙池镇虹口风景区有一个三文鱼养殖基地。该三文鱼养殖基地建在白沙河上游。该基地依托虹口高山融雪水资源，养殖金鳟、虹鳟、西藏亚东鲑、北极红点鲑以及其它鱼类。

贵州省毕节市大方县大山乡松鹤村蚂蚁河建有三文鱼养殖基地，通过挖渠，从溶洞引水，形成流水养殖生境。其部分三文鱼鱼卵来自西班牙，养殖有鲑鳟、虹鳟等。

（五）黄渤海中的鲑鱼养殖

20 世纪 70 年代开始，中国的水产专家就曾尝试在青岛、大连、烟台等北方开放水域养殖大西洋鲑，均以失败告终。

自 2015 年 5 月起，来自中国海洋大学等的专家组成的科研团队与公司合作，开始在黄海冷水团海域进行了冷水性三文鱼养殖试验。2017 年，名为“深蓝 1 号”大型养殖网箱装备建成下水，主要养殖虹鳟，亦有大西洋鲑。“深海养鱼”也面临诸多不可控因素。“深蓝 1 号”在养殖过程中就出现过网箱因为海水腐蚀而破洞，导致大部分鲑鱼逃逸。目前，“深蓝 2 号”也已投入使用。

另一家在黄海开展虹鳟鱼养殖的是中国水产科学研究院黑龙江水产研究所。该所在黑龙江省牡丹江市实施的虹鳟鱼“水科 1 号”项目。该项目通过对宁安市虹鳟鱼钻心湖种源基地提供 90 多万尾鱼苗和成鱼，进行入海盐化实验。自 2020 年开始，黑龙江水产研究所通过调整水环境，使虹鳟鱼体内各种器官和功能逐步从淡水环境适应海水环境。利用深海冷水团扩大养殖面积，实现虹鳟鱼陆海接力养殖模式。其分别在黑龙江省的宁安、哈尔滨、以及黄海地区的大连、烟台、渤海的东营等试验基地，使用从体重 10 克、50 克到 3 斤的不同规格虹鳟鱼鱼苗和成鱼共计 90 余万尾。

三、保护建议和对策

（一）鲑鱼养殖中的污染问题较为突出。

鲑鱼养殖场让鱼类排泄物和食物残渣直接落入水体，在周围水域积聚过多的营养物质，如氮和磷，会破坏水域生态系统和原生动植物群落。此外，在鲑鱼养殖中，过度使用抗生素、防污剂和杀虫剂等化学品会对水生生物和人类健康造成不良后果。

（二）鲑鱼养殖中的动物福利问题不容忽视。

养鱼场的鲑鱼被关在狭小的空间里，每条鲑鱼的活动空间十分有限。过度拥挤的鱼类更容易生病，遭受的压力、攻击和身体伤害（如鳍损伤）也更多。除了空间不足，过度拥挤还会导致水质变差，使鱼呼吸的氧气减少。鲑鱼是洄游鱼类，自然中会长距离迁徙，集约化鲑鱼养殖的条件不可能满足鲑鱼的基本需求。

（三）野生鲑鱼的保育应获得重视。

东亚地区的各种野生鲑鱼种群都面临濒危境地。各国和地区可以相互交流保育经验、促进相互学习和合作。例如，台湾樱花钩吻鲑保育工作的经验教训可以学习借鉴。同时，东北亚各国鲑鱼研究机构和保护区之间，可以通过互访交流、举办国际会议，共同促进东亚地区的野生鲑鱼物种资源的保护。此外，中国和与北美鲑鱼保护机构之间，也可以建立对话和交流机制等。

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"异宠"饲养背后的风险隐患

杨洪兰 李利红 韦琦

摘要：有些追求时尚、新潮和猎奇的宠物爱好者，打破了人们长久以来饲养猫、狗、鸟、观赏鱼等传统宠物的观念，开始饲养另类宠物，如水族宠物、小型哺乳动物、昆虫等，这些另类宠物被称为"异宠"。这些被人们当作宠物饲养和观赏的野生动物（也包括野生植物），它们可能来自野外或是野生种源人工繁育的后代，且往往来自其他国家和地区。宠物爱好者通过非法途径或渠道将其偷渡到国内，这些外来物种可能会与国内本土生物争夺资源、抢夺生态位置，从而破坏生态平衡，而且有些外来物种甚至自身带有剧毒，或者携带疫病，具有对国内的生态环境和人身安全造成重大影响的潜在风险隐患。

关键词：异宠，生物安全，外来物种，非法入境，生态风险

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一、异宠行业的兴起引发的问题

国门生物安全是国家安全体系的重要组成部分，而海关是国门生物安全和生物多样性保护的第一道防线。据媒体报道，北京海关2024年第一季度从旅检、邮递、快件等非贸渠道截获禁止进境动植物及其产品933批次，包括截获加拉帕戈斯巨人蜈蚣、巨扁锹甲、长戟犀金龟、秃额后目蝎等外来物种198种次。从这些数据可以看到，随着国际贸易和人员往来的频繁交流，境外物种传入国内的途径不断增多，传入风险持续加大。

这些外来物种入境的主要诱因就是"异宠"。近年来，随着生活水平的提高和经济的发展，人们精神方面的需求也逐渐提升，养宠物的人越来越多。其中有些人已经不满足于养猫狗等传统宠物，而是标新立异，养一些与众不同宠物，即"异宠"。于是，市场上出现了各种各样的异宠，如蜥蜴、鳄雀鳝、热带龟、各种热带鱼等。异宠行业得到了快速而野蛮的发展。跨国邮件、快递、出入境旅游等非贸易渠道凭借灵活、快速优势，成为"异宠"入境重灾区。国内"异宠"爱好者一般会通过网络联系，卖家再通过寄递的方式将所购物种发送至国内，也有的通过出境旅游直接放在行李箱中托运带回国内，这些外来物种有的用于自用（观赏），有的在市场上公开销售，销售渠道包括各

类线上购物平台，甚至朋友圈、聊天群等，而线下销售渠道则主要是异宠咖啡厅、宠物店、亲子乐园等。

异宠行业的商家出于利益的追求，开始向广大普通群众宣传兜售各种各样五花八门的宠物。于是，很多普通人在还没有了解和认识到异宠的习性、可能的生态危害等信息时，出于冲动、跟风或猎奇等诸多原因，购买并开始饲养异宠。部分饲养者购买异宠后，无法完全做到负责任地饲养异宠。由于种种个人原因（比如，不喜欢异宠了，家庭条件不再适合养异宠，不想养且送人无人接收等），异宠就被“放生”或遗弃，进入了当地生态系统。一个外来物种的入侵，不仅会破坏、改变当地的生态环境，威胁当地的生物多样性，而且还可能会因携带疫病病毒、细菌、寄生虫等，对当地生态系统造成影响，进而对社会经济和人民群众生活秩序、甚至是人身健康和生命安全造成严重负面影响。

生态系统是经过长期的自然演化形成的，某个区域生态系统中的物种经过漫长的竞争、排斥、适应和互利共存，才达到生态平衡，形成相互依赖、相互制约的共生共存关系。外来物种在我国境内无天然分布，其中一部分没有天敌制约，因此生命力很强大，容易迅速占领某个区域的生态系统，从而对该系统中的其它物种造成毁灭性的影响。

【案例一】非洲大蜗牛原产于非洲东部，由于个体大，外形美观，曾被人们作观赏品和食物直接引入，但是，它能够对500多种植物产生危害，包括农作物、林木、果树、蔬菜、花卉等，是许多人畜寄生虫和病原菌的中间宿主，尤其会传播结核病和嗜酸性脑膜炎。非洲大蜗牛已被列入《中国第一批外来入侵物种名单》。

【案例二】2022年夏，一则关于“抽干湖水围捕‘怪鱼（即鳄雀鳝）’”的新闻冲上热搜，引发了人们对异宠问题的热烈讨论：2022年7月，河南汝州中央公园云禅湖出现鳄雀鳝。公园从2022年7月26到8月26日这一个月的时间里，抽干了20-30万立方米的湖水，只为抓捕两条鳄雀鳝。首先，为抓捕鳄雀鳝而抽干湖水的做法，对水生生物、整个水域底部和堤岸都会带来较大的环境变迁和冲击，这是坚决反对的。其次，这反映出了异宠引入带来的外来入侵物种问题。鳄雀鳝本为北美物种，其引入与近年来不断发展的异宠产业有着紧密关联。我国大部分生态系统中缺少外来

物种鳄雀鳝的天敌，尤其是在幼鱼达到一定体型后，这导致鳄雀鳝的存活率远远高于原产区域。在中国的南方地区，有养殖户反馈，几条鳄雀鳝进入鱼塘的一两年后，其他鱼类基本都被鳄雀鳝捕食。

二、异宠饲养需注意的几点

对待异宠饲养，应持严肃谨慎的态度：

首先，要辨别“异宠”是否属于国家重点保护的珍贵、濒危野生动物。因为有不少违法犯罪分子在利益驱使下，打着“异宠”的幌子实施破坏野生动物资源的犯罪行为，如果明知是国家重点保护的珍贵、濒危野生动物，仍进行非法买卖，可能会涉嫌危害珍贵、濒危野生动物罪。并且还要注意到，在购买的过程中，凡是涉及国家重点保护的珍贵、濒危野生动物的，无论采取何种运输方式，以及为运输、仓储、保管、快递、邮寄等提供便利条件的，均可能会涉嫌犯罪，如果存在走私行为，则加重处罚。

其次，携带动植物、动植物产品和其他检疫物进境时，须如实申报，并接受检疫。根据《进出境动植物检疫法》第四十一条的规定：“携带动植物、动植物产品和其他检疫物进境的，进境时必须向海关申报并接受口岸动植物检疫机关检疫。未经检疫的，不得携带进境。”同时，《外来入侵物种管理办法》第十条规定：“因品种培育等特殊需要从境外引进水产苗种等外来物种的，应当依据审批权限向省级以上人民政府农业农村、林业草原主管部门和海关办理进口审批与检疫审批。属于首次引进的，引进单位应当就引进物种对生态环境的潜在影响进行风险分析，并向审批部门提交风险评估报告。经评估有入侵风险的，不予许可入境。”因此，携带植物种子、种苗及其他繁殖材料进境，须事先提出申请，办理检疫审批手续。携带伴侣犬、猫等动物进境，须持有输出国家或地区的检疫证书和狂犬病免疫证书。禁止携带农业部公布的《禁止携带进境物名录》中的各物进境。

最后，如果正在饲养的异宠不想养了，绝对不能随意放生或者丢弃。否则，可能会承担民事甚至是刑事责任。因为根据《民法典》第一千二百四十九条的规定：“遗弃、逃逸的动物在遗弃、逃逸期间造成他人损害的，由动物原饲养人或者管理人承担侵权责任。”同样，随意放生可能会触犯刑法，根据《刑法》第三百四十四

条之一的规定："违反国家规定，非法引进、释放或者丢弃外来入侵物种，情节严重的，处三年以下有期徒刑或者拘役，并处或者单处罚金。"《生物安全法》对此也有相关规定，该法第八十一条对未经批准擅自引进外来物种和未经批准擅自释放或者丢弃外来物种的行为明确了相关法律责任。因此，如果饲养的异宠不想养了，一定要将其送至相关的专业机构进行处理或者安置。

三、结语

近年来，以"异宠"为名流入国内的动物，很多属于入侵物种，已经给国内的生态系统特别是对关系国计民生基础的农业系统造成了很大的不利影响。2023 年中央一号文件《中共中央、国务院关于做好 2023 年全面推进乡村振兴重点工作的意见》明确指出："严厉打击非法引入外来物种行为，实施重大危害入侵物种防控攻坚行动，加强"异宠"交易与放生规范管理。"

此外，异宠对国际贸易也产生了重大负面影响，对异宠的追捧，是导致活体野生动物非法贸易日渐猖獗的重要原因，而全球野生动物及其制品的非法贸易，已成为仅次于军火、毒品的第三大走私行业。

最后，将异宠和野生动物圈养在家里，这不符合生态文明和新时代的生物伦理，让异宠在其原栖息地繁衍生息，才是生态文明。

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全球塑料条约为何被推迟？

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摘要：塑料的生产和污染始于几十年甚至一百年前。塑料污染问题一直是全球环境政治中的突出问题。在联合国环境规划署（UNEP）框架下，各国正在谈判制定一项国际塑料制度，以终结塑料污染。该文书的形成仍取决于谈判。本文旨在通过对经济和政治方面以及化石塑料替代品的可用性的整体回顾，回答为什么关于塑料污染的多边环境协定（MEA）被推迟。本文发现五个方面的因素共同推迟了塑料多边环境协定的有效形成和实施。而关于塑料制度何时能有效解决塑料污染问题，甚至何时能发挥效力，都难以预测。

关键词： 塑料污染，多边环境协定，国际谈判委员会，全球环境治理，生物塑料

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（注：中文提供摘要，全文请见英文部分。）

重大基建工程弃渣资源化利用现状、问题及建议

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摘要：重大基建工程在建设过程中，不可避免地会产生大量的弃土弃渣（石）。弃土弃渣（石）资源化利用程度不高，弃渣资源综合效益未能充分发挥。究其原因，主要有再利用起步晚、存量及组成不够清楚，信息不对称、供需双方沟通困难，缺乏配套制度、再利用程序不健全，利用方式粗放、存在环境风险隐患等。目前，地方乡村振兴砂石资源需求量大，弃渣资源化利用具备了法律保障，利用技术较为成熟且效益显著。已有弃渣资源化利用的成功案例，对重大基建工程弃渣资源化利用具有可行性。为此，提出弃渣资源化利用的对策建议，可有效缓解乡村振兴建设的砂石资源需求，有力助推地方乡村振兴战略的实现。

关键词： 重大基建工程，弃渣，资源化，乡村振兴

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党的十八大以来，我国交通、水利、能源以及新型基础设施建设等领域取得了全方位、开创性历史成就。重大基建工程在建设过程中，不可避免地会产生大量的弃土弃渣（石）[1]。弃渣堆放不仅占用大量土地，增加建设投资，而且极易造成水土流失，是工程建设的一大难题。山区、丘陵区的重大基建工程，由于受地形、地质和施工运距等条件的限制，弃渣场通常布设在沟道中，遇降雨和上游来水，如防护不到位会造成严重的水土流失、生态环境破坏，并可能诱发滑坡、泥石流等地质灾害，严重威胁项目区及下游地区重要基础设施及人民群众的生命和财产安全[2]。十多年前有学者已经总结分析了土石方优化调配模型、土石方调配管理系统、土石方调配多目标优化等问题[3]，目前城市建筑垃圾的回收和再利用取得了一定的成效，但重大基建工程弃土弃渣（石）资源化利用程度不高，弃渣资源综合效益未能充分发挥。弃土弃渣（石）不能充分资源化利用的原因，一方面是由于弃渣资源供需双方信息的不对称，导致弃渣资源的严重浪费；另一方面是弃渣管理涉及自然资源、水利、生态环境等多个部门，不同项目间综合调配协调难度较大。

早在2013年5月，习近平总书记强调，“节约资源是保护生态环境的根本之策。要大力节约集约利用资源，推动资源利用方式根本转变，加

强全过程节约管理，大幅降低能源、水、土地消耗强度，大力发展循环经济，促进生产、流通、消费过程的减量化、再利用、资源化”。2023 年 7 月，习近平总书记在全国生态环境保护大会上强调：“要加快推动发展方式绿色低碳转型，坚持把绿色低碳发展作为解决生态环境问题的治本之策，加快形成绿色生产方式和生活方式，厚植高质量发展的绿色底色”。加强重大基建工程弃土弃渣的资源化利用，既是保障人民生命和财产安全的迫切需要，又是新时代新征程建设人与自然和谐共生现代化的必然要求。

一、必要性与可行性

（一）地方乡村振兴砂石资源需求量大

砂石是建筑、道路、桥梁等基础设施工程建设用量最大、不可或缺、不可替代的基础材料。近年来我国砂石骨料行业的销量一直保持增长态势，据统计：过去 15 年中，全国砂石用量出现正增长的年份为 12 年，增长最多的年份达 15%。乡村振兴战略涉及到大量的基建场平工程、交通工程和土地整治等项目，对各种建筑砂石的需求量也在不断攀升。乡村振兴项目的实施必须要有充足的砂石资源保障项目建设需要，同时要有可控的价格水平保障工程预算。传统小微矿山具有开采效率低、生产造成的环境污染大、污染处置不规范等缺陷，不但侵损了国家矿产资源，还对生态环境造成了严重破坏。随着最严格环保制度的实施，对矿山开采实施了限采、禁采严令；河道采砂管控和治理也越来越严，不允许开采自然砂，这就造成砂石资源供不应求的局面，进而导致砂石价格的较大上涨。

（二）弃渣资源化利用具备了法律保障

《中华人民共和国水土保持法》第二十八条规定：“依法应当编制水土保持方案的生产建设项目，其生产建设活动中排弃的砂、石、土、矸石、尾矿、废渣等应当综合利用；不能综合利用，确需废弃的，应当堆放在水土保持方案确定的专门存放地，并采取措施保证不产生新的危害”。《中华人民共和国固体废物污染环境防治法》第六十一条规定：“国家鼓励采用先进技术、工艺、设备和管理措施，推进建筑垃圾源头减量，建立建筑垃圾回收利用体系。县级以上地方人民政府应当推动建筑垃圾综合利用产品应用”。《中华人民共和国长江保护法》第六十九条规定：“长江流域县级以上地方人民政府应当建设废弃土石渣综合利用信息平台，加

强对生产建设活动废弃土石渣收集、清运、集中堆放的管理，鼓励开展综合利用”。以上相关法律为弃渣资源化利用提供了法律依据。

（三）利用技术较为成熟且效益显著

不同于矿山开采和工业固体废物，重大基建工程弃渣虽然因岩石特性会存在一定差异，但来源十分广泛，有明挖料、洞挖料或明挖与洞挖混合料，基本不含污染物质，便于弃渣的资源化利用。对乡村振兴中一般的场地平整等项目，工程弃渣可以直接使用；对于常规的砂石骨料，工程弃渣机制砂工艺十分成熟，具有质量可控、性能优秀、绿色环保等三大优势。受施工工艺、施工组织等因素的影响，大量工程弃渣得不到合理利用，且堆放和处置困难，直接废弃会影响项目区生态环境。同时，乡村振兴项目对填料、砂石骨料需求量大，但往往因交通不便、外购运距较远，导致获取难度大且成本较高。弃渣资源化利用，既可以减少工程弃渣和占地，降低建设项目水土流失和环境污染防治费用；又可以解决乡村振兴用砂石骨料的难题，减少取土（石）对原地表植被的破坏，实现了工程建设和环境保护的双赢。

（四）已有弃渣资源化利用的成功案例

根据前期调查，目前已有已建或在建重大基建工程开展弃渣资源化利用的成功案例。例如雅康高速公路喇叭河互通设计为综合体，能消化附近6个隧道的弃渣100万m^3，既有效解决弃渣难题，又节约弃渣占地[4]；香丽高速公路作为典型的山区高速，利用隧道弃渣生产高等级混凝土专用碎石，解决了项目建设的材料保障问题[5]；新成昆铁路眉山市东坡区段，利用弃渣对当地的橘园和茶园进行土地整合，盐边车站利用弃渣支持打造物流工业园区，新增用地约200亩[6]；新建南昌经景德镇至黄山铁路建立了环保、智能化的洞碴加工场，共生产三个级配碎石、机制砂和石粉五种产品，洞碴综合利用率高达95%以上，可以减少三个弃碴场以及4公里临时便道的建设，直接减少耕地林地占用150亩[7]；位于太行山脚下的南水北调中线雄安调蓄库弃渣综合利用项目，预计每年能生产2500万吨砂石骨料，可满足雄安新区10-15年建筑骨料需求，同时帮助破解矿山修复难题[8]。

二、弃渣资源化利用存在的问题

（一）再利用起步晚，存量及组成不够清楚

随着生态文明建设的不断推进，工程弃渣综合利用才逐渐得到重视。目前，水利部门加大了对生产建设项目的监管，在建工程弃渣位置数量等信息可以动态、系统地掌握；但大量的已完建项目的弃渣场的状况缺乏跟踪调查，弃渣场总量以及存量不清。此外，工程弃渣因为其来源不一，所以岩土性质会存在一定的差异，不同组成的弃渣资源的综合利用方向有所区别，因此，组成不清也会影响弃渣综合利用。

（二）信息不对称，供需双方沟通困难

《中华人民共和国长江保护法》规定长江流域县级以上地方人民政府应当建设废弃土石渣综合利用信息平台，但目前该信息平台尚未建立，工程弃渣方与弃渣利用方存在信息不对称，供需双方沟通存在障碍。现有的弃渣综合利用大多局限于工程自身的综合利用，与其他工程的调配利用尚处在探索阶段。因此亟需搭建包含在建和已建重大基建工程的废弃土石渣信息平台，为弃渣综合利用创造条件。

（三）缺乏配套制度，再利用程序不健全

弃渣资源本质上属于自然资源，弃渣综合利用还存在权责不清，再利用程序不健全的问题。在建工程弃渣的主要责任是建设单位，弃渣用于其他工程存在乱堆乱弃的嫌疑，建设单位将面临行政处罚的风险。已建工程弃渣通过验收后将移交地方政府，而此时弃渣再利用类似新增取土采石项目，再利用手续也相当复杂。缺乏相关弃渣再利用的配套制度，成为制约弃渣再利用的主要因素。

（四）利用方式粗放，存在环境风险隐患

目前，除了工程弃渣的自身利用外，弃土主要用于土地整治、废弃矿坑治理等，而弃渣则主要用于基础填筑等，利用方式相对单一且粗放。乡村振兴项目也需要大量的砂石骨料，利用弃渣制备砂石骨料会涉及破碎、筛分、制砂方式等环节，以及生产方法和设备工艺的选择等。由于乡村振兴项目投资小而且分散，若选用的设备工艺落后且环保措施跟不上，会存在环境违法的风险。

三、对策与建议

（一）摸清弃渣家底、掌握弃渣资源的现状

由于弃渣组成与所在地质环境密切相关，不同类型工程所产生的弃渣也不同，掌握弃渣存量和组成才能因地制宜地开展再利用。建议相关部门调查近20年来审批的工程弃渣情况，包括堆渣量、渣场类型以及弃渣场分布等；自然资源部门根据区域地质特点，初步分析各类弃渣场的组成成分，建立已建和在建工程弃渣资源基础信息库，进而掌握弃渣资源的现状，为弃渣的进一步利用奠定基础。

（二）搭建数据平台、共享弃渣信息资源

各省级自然资源部门应尽快牵头推进废弃土石渣综合利用信息平台的建设工作，同时将相关部门的在建工程弃渣等信息纳入其中。信息平台建立初期可在有限范围试用，对地方各级政府及自然资源、水利等部门公开，其他弃渣利用方作为用户可在平台提出综合利用的需求，信息平台管理方负责弃渣资源的综合调配。信息平台建立成熟后，进一步扩大公开的范围，进一步优化信息平台的运用等。

（三）建立配套制度、优化弃渣再利用程序

针对弃渣再利用的不同阶段，建议自然资源和水利、生态环境等部门联合制定弃渣综合利用管理办法，明确已建和在建工程弃渣综合利用所需履行的程序和手续。适当简化乡村振兴项目的弃渣综合利用手续；对于零散扶贫项目的弃渣再利用，探索专项监理替代行政管理的方式；对于已建工程弃渣的再利用，优化临时用地审批、减少临时用地补偿等；引入社会资本、制定金融税收政策，鼓励弃渣的再利用。

（四）加强技术研究，适应绿色低碳新要求

在生态文明相关政策的引导和规范下，以绿色低碳为标志的高质量发展必然成为新的形势。弃渣的种类繁多，不同利用方式涉及的环节和处理方法不同，要根据不同组成和利用需求制定差别化的利用方案。加强新型设备和关键技术的研究，通过研制新的处理方法和技术设备，合理选择加工工艺和设备，并通过加强质量控制，为乡村振兴提供优质的砂石资源，建设人与自然和谐共生的现代化乡村。

四、结语

党的二十大报告指出，全面推进乡村振兴，坚持农业农村优先发展，坚持城乡融合发展，畅通城乡要素流动；统筹乡村基础设施和公共服务布局，建设宜居宜业和美乡村。随着国家对新发展阶段优先发展农业农村、全面推进乡村振兴做出总体部署，在优化空间布局、推进产业发展、加强基础设施建设、完善基本公共服务等领域，需要实施大量的乡村振兴建设项目。利用已建或在建重大基建工程产生的弃土弃渣（石），开展弃土弃渣（石）资源的减量化、再利用和资源化，不仅能保障项目区人民生命和财产安全，而且能有效缓解乡村振兴建设的砂石资源需求，有力助推地方乡村振兴战略的实现。

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论绿色建筑政策体系中的“生物多样性保护”缺失：“燕子砖”是否可成为绿色建筑的标签？

沈一杭

摘要：目前，各地的“绿色建筑”有关政策法规和标准，普遍存在一个问题：没有考虑到“生物多样性保护”。也就是说，割裂了应对气候变化与保护生物多样性的协同增效。基于此，本文通过具体的案例分析，探讨“究竟什么样的建筑能被称为‘绿色建筑’”。本文认为，建筑业作为一个对生态系统和自然环境影响深远的行业，应当在应对气候变化的同时，兼顾生物多样性保护的重要性。

关键词：绿色建筑，燕子砖，气候变化，生物多样性

沈一杭.论绿色建筑政策体系中的“生物多样性保护”缺失：“燕子砖”是否可成为绿色建筑的标签？.生物多样性保护与绿色发展.第 1 卷，2024 年 5 月，总第 61 期.ISSN2749-9065

为了推动绿色发展，中国多地出台了有关绿色建筑的政策法规和标准。这些政策旨在促进建筑行业向环保、节能、可持续方向转型，以应对日益严峻的环境挑战和资源压力。各地政策的制定涵盖了建筑节能标准的提升、绿色建筑评价体系的建立、政府奖励和财政支持等方面，鼓励开发和采用具有高能效、低碳排放、资源节约和环境友好特性的绿色建筑技术和材料。诚然，这些政策的实施将有助于推动建筑行业向更加可持续的发展模式转变，为未来城市建设和生活环境的改善提供有力支持。

但是，我们回到一个最初始的问题——究竟什么是“绿色”呢？如果一个建筑物为了实现生物多样性友好，装配了“燕子砖”来供燕子栖息、筑巢，那么这个建筑能被称为“绿色建筑”吗？

很遗憾，按照目前的中国任何地方的“绿色建筑”的政策法规、标准，都不算。

事实上，目前各地的“绿色建筑”有关政策法规和标准，普遍存在一个问题：没有考虑到“生物多样性保护”。也就是说，割裂了应对气候变化与保护生物多样性的协同增效。建筑业作为一个对生态系统和自然环境影响深远的行业，应当在应对气候变化的同时，兼顾生物多样性保护的重要性。割裂应对气候变化和保护生物多样性的努力可能导致无法全面解决环境问题，因此在制定绿色建筑相关政策时，需要综合考虑生物多样性保护，实现环境保护的全面性和协调性。

在中国南方许多民间建筑中，老百姓的砖瓦房的顶部常常带有镂空结构，成为了事实上的类似于“燕子砖”之类的人工栖息地。笔者在调研中观察到常有鸟类出入这些房屋上的空穴。

摄影：Linda ©绿会融媒·“海洋与湿地”（OceanWetlands）工作组

中国领导人曾经在联合国《生物多样性公约》（CBD）第十五次缔约方大会上强调过：要以生物多样性保护推动绿色发展。然而，目前许多关于绿色发展的政策，仍然是完全没有把生物多样性保护考虑在内的。

事实上，绿色建筑的“生物多样性友好性”是大有可为的。比如英国在大力推广的燕子砖，就是在建筑物上增加一个可以供小燕子作为栖息地的特殊的砖块，就能大力的改善该国燕子的濒危状态。又比如，立体绿化、玻璃幕墙光污染带来的“鸟撞”事件，都是“绿色建筑”大有可为的空间。

燕砖 来源：Manthorpe Building Products’ factory

一只雨燕从筑巢砖中探出头来 来源：Ben Andrew/RSPB

以《北京市建筑绿色发展条例》（以下简称“条例”）为例，该条例已由北京市第十六届人民代表大会常务委员会第六次会议于2023年11月24日通过，自2024年3月1日起施行，里面并没有涉及到有关生物多样性友好的内容。近日，因为北京市住房公积金管理部门出台了《关于住房公积金支持北京市建筑绿色发展的实施办法（征求意见稿）》，笔者发现如若这一政策能够得到很好地辅助实施，老百姓很快能享受到“绿色建筑”带来的财政激励，然而非常遗憾，《北京市建筑绿色发展条例》从第一条“为了贯彻绿色发展理念，节约资源能源，减少污染和碳排放，提升建筑品质，改善人居环境，推动建筑领域绿色低碳高质量发展，根据有关法律、行政法规，结合本市实际，制定本条例”，这一条就很可惜——是有缺陷的，因为完全没有考虑到“生物多样性友好”。

换句话说，上面提到的“绿色建筑”法规，没有包括保护生物多样性的因素，而是更侧重于节能、资源利用和环境保护方面的特征。这可能反映了在绿色建筑概念的定义和实践中，对于生物多样性保护这一方面的关注程度相对较低的一个非常令人尴尬的现状。

其实这并不是个例，据笔者观察，这是中国立法层面很普遍的一种现象、误区——将“生物多样性保护”与“应对气候变化”割裂开来。这一误区，也说明了以下几个问题：

一是绿色建筑定义的局限性。

传统上，绿色建筑主要关注的是减少能源消耗、降低碳排放、优化资源利用等方面，而对于生物多样性的保护并未得到足够的关注。这种定义的局限性导致了人们对于绿色建筑的认知更多地集中在能源效率和环

境影响减少方面，而对于生态系统和野生动植物的影响却不够重视。

二是生物多样性保护的重要性。

生物多样性是指地球上各种生物体系的丰富度和多样性，包括不同物种的存在和互动，以及各种生态系统的形成和维持。保护生物多样性对于维护生态平衡、保护自然资源、维护生态系统功能和人类福祉都至关重要。建筑业作为一个消耗资源和能源较大的行业，其发展对生物多样性可能造成一定程度的影响，因此在绿色建筑的定义和实践中应当考虑生物多样性保护的重要性。目前，在政策制定的层面，还缺少这些方面的主流化。包括在决策咨询中，也缺少生物多样性方面的专家的参与。

三是跨学科综合考量的不足。

这一认识误区也反映在绿色建筑设计和评价中，跨学科综合考量的不足。这可能也跟我国长期以来的专业分割人才培养模式有关。事实上，绿色建筑的概念应当涵盖环境、社会和经济等多个方面，而生物多样性保护则属于环境保护的重要内容之一。目前普遍的设计者在思维上，一想到“绿色”,就把这个概念等同为了“节能”。而事实上，“绿色”的内涵具有更多广义性和外延型。没有鸟语花香，能叫做“绿色”吗？到处都是水泥，只有人的喧嚣却没有大自然的和声，这样的建筑再节能节水，能是“绿色建筑”吗？所以，为了实现更全面的可持续发展目标，绿色建筑的定义和评价需要从更广泛的视角出发，充分考虑生物多样性保护等生态系统服务。

放眼全球，以英国为例，不光鼓励“燕子砖”之类的硬件用于建筑设计，在全部的建设开发思路上，也引入了生物多样性净增益（BNG）的概念。先不说生物多样性净增益（BNG）好不好、是否完善，但一点可以肯定：他们认识到了人类的开发本身是生物多样性丧失的主要因素，因此，试图在建筑行业中予以某种方式的补偿。

它山之石，可以攻玉。绿色建筑的概念内涵、实践、立法和标准都应要融入“生物多样性友好”，这一点是毋庸置疑的。

展望未来，我国建筑行业的绿色发展亟需向综合性和全面性发展。这一误区也在提醒我们，绿色建筑行业发展中，需要向更综合和全面的方向努力，提高对生态文明的认识水平。绿色建筑应当成为生态文明建设的重要组成部分，综合考虑节能、资源利用、环境保护以及生物多样性保护

等方面的因素，实现对自然和人类社会的双重利益的平衡。

因此，解决这一误区的关键在于推动绿色建筑概念向更全面和综合的方向发展，将生物多样性保护等生态价值纳入到绿色建筑的定义和实践中，促进建筑行业在可持续发展路径上的进一步完善与创新。

四通贺辞

胡德平

摘要：本文是四通集团成立四十周年的一篇贺辞，从“四通的诞生”、“四通的起落”、“凯赛新局”三个方面展开。“自由组合，自筹资金，自主经营，自负盈亏”，这是一切民营企业的共性，也是民营企业存亡绝续的生死运营状。

关键词：四通，民营企业，经营管理

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一、四通的诞生

第一次听到“四通”的大名，还是“四通”人说的那四句话：“自由组合，自筹资金，自主经营，自负盈亏。”这是一切民营企业的共性，也是民营企业存亡绝续的生死运营状。说得光明磊落，一切胜利失败，绝不诿过于人。这四句话不简单，这表示着能够承担民事能力的一代新人开始出现。今天民营企业还是这么一句话：我们不要求对民企的优惠政策，只求平等的国民待遇，不得歧视而已。当“四通”发展到和国外十八个公司组成合资公司时，他们又有一句名言：“必须站在巨人的肩膀上，环视世界”。

四通公司有如此不同凡响的见地，不是偶然的。1980 年，北京市科技干部陈春先，参观了美国硅谷科研产业基地后表示，也要建立中国的硅谷，首先办起了第一家民办咨询公司。1984 年以前，少数国家的科技人员，以采取停薪留职的方法，兴办了几家科技企业。四通在酝酿注册公司时，当时的海淀区党委书记表示了极其果决的态度：国家科技人员办民营企业，必须辞去公职，净身下海才可置之死地、背水一战。新生的四通公司的名字，据说是于光远同志所取，不知其意如何，是否寓意要作改革事业的投路石、路基石。

在一次召开政协会议时，讨论如何惩治贪污腐败分子问题，段总说了他的三点意见：第一，应该严厉惩处官商勾结的腐败官员，使其不敢腐；第二，深入教育各级干部，树立远大理想，使其不想腐；第三，关键是体制改革，建立对各级政府行施权力的监督机制和问责制度，使其不能腐。这是笔者第一次听到这种话语。不像民企的话，而像官方语言。

二、四通的起落

四通业务的主攻方向是电子信息产业，当四通推出中英文打字机后，中办大量采购。中办还举行了几期计算机的辅导和培训工作。1984 年，胡耀邦同志有一次还步行到中南海西门的培训班场所，向四通的专业人员请教计算机的基本知识和操作方法。他认为，计算机的应用，完全可以进入中办办公自动化的文秘流程。1985 年的“中央一号文件”，就是使用打字机技术和激光照排技术打印出来的文件。趁着汉字顺利输入计算机时代的开始，中央做出决定将“中国文字改革委员会”更名为“国家语言文字工作委员会”，这是中国文化进入世界文化中的一种特殊文明。

四通股票于 1993 年 4 月在香港上市，成为我国第一家在海外上市的公司，即时成为中国企业步入世界资本市场的第一家，风头极劲。惜乎 16 年后又在香港退市，其原因是履行了上海法院判决，清还某公司 27 亿的经营亏损，乙公司亏损要甲公司还钱，四通对此判决至今仍持抗争辩诬的态度，但照样执行了法院判决，卖出了新浪等优质股票，表现了一个企业身处市场风浪之中，荣辱不惊，从容坦诚的品质。回想段总对民企经营的一句戏言：“拆东墙补西墙，墙墙不倒；借新债还旧债，债债归还。”横批：“剩者为王。”在市场经济中，能输又能赢，从不矫情、气度不凡，让人敬佩。可是……

三、凯赛新局

四通退市以后，其业务是如何发展的呢？1994 年，中国留美博士刘修才经国家领导人廖晖、钱伟长的邀请回国创业。他研究的生物合成技术引起段总的兴奋和重视，他不失时机地下了一步先手棋，将四百万美元投资了刘修才的凯赛公司，支持刘修才走出高校院所，走上一条产学研之路。先后在山东、吉林、新疆、山西投资置业，并于 2020 年在上海证券交易所上市。凯赛生产的长链二元酸取代了美国杜邦集团生产的同类产品；其生物合成技术颠覆了用化石原料进行生产的传统技术。

科技公司的发展道路充满艰辛，笔者认为四通和段总的贡献就是：单一美国科技创新公司很难在中国迅速生根落地，惟有比较了解两国企业的经营管理情况，因地因时、因人制宜举办企业，外国的尖端技术才能在中国本土生存、成长。前些日子凯赛公司已获国家的重要认可，公司的股价才面目真显，不再阴阴晴晴，涨涨

停停，进入了稳固上升良性发展的阶段。

最后，衷心祝贺四通集团成立四十周年，基业长青！这是大时代中的一则小故事，吉光片羽，雪泥鸿爪，特别耐人寻味。

2024 年 5 月 11 日

以沙产业探索农业水资源高效利用的“新质生产力”

王晓琼　王静

摘要：水资源与粮食安全存在着密不可分的关系。水资源是农业生产的关键要素，是影响粮食安全的刚性约束，如何对其进行合理的开发利用、提高利用效率成为国家粮食安全战略的关键一环。认识并践行沙产业，能帮助人们辩证的认识干旱半干旱地区的自然条件，正确理解防治荒漠化与合理开发利用水资源之间的关系，从而树立起寓防治于开发利用之中，以开发利用促治理，以治理确保开发的策略思想。本文以沙产业探索，提出通过扶持和推广关于沙产业的新思维、新方法与新模式和新样板，探索形成水资源高效利用的“新质生产力”的可行性方案。

关键词：水资源，沙产业，第六次产业革命，新质生产力

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一、背景

水资源与粮食安全存在着密不可分的关系。2023 年世界粮食日的主题为“水是生命之源，水是粮食之本，不让任何人掉队”，再次强调了水资源在保障粮食安全中的重要作用。作为农业生产的关键要素，“水”是影响粮食安全的刚性约束，如何对其进行合理的开发利用、提高利用效率成为国家粮食安全战略的关键一环。

中国是人口大国，同样是农业大国。据国家统计局发布数据显示，截至 2023 年年末，全国人口 140967 万人。如此庞大的人口基数，对粮食的基本需求量巨大，如何“藏粮于地、藏粮于技”，确保把饭碗牢牢端在自己手中是国家粮食安全的根本战略方向。这其中，“水”的作用不言而喻。

二、全球水资源储备与利用

尽管地球上水量丰富，但绝大多数不能被直接利用，可利用的淡水资源极其有限。陆面上的有限水体也不全是淡水，淡水量仅有 0.35 亿 km^3，其中的 0.24 亿 km^3 分布于冰川、多年积雪、两极和多年冻土中，现有技术条件很难利用。而便于人类利用的水只有 0.1065 亿 km^3，占淡水总量的 30.4%，仅占地球总储存水量的 0.77%[1]。特别是在近年来持续加剧的全球气候危机影响下，各种资源均受波及，水资源问题同样也异常严峻。由于资源分布不均，可耗竭性、负外部性、在国民经济中的主导地位不同，不同资源安全治理领域的碰撞与矛

盾逐渐突出[2]。

联合国粮农组织总干事屈冬玉指出：“农业是世界淡水资源的第一消费大户，占全世界淡水取用量的70%。”然而时至今日，世界超过三分之一的人口仍然无法获得安全用水。屈冬玉认为，确保全球水安全是实现联合国2030年可持续发展议程的根基所在。水资源的合理保护与可持续利用，已经成为减少饥饿和贫困的可持续发展目标的重要基础。

三、中国农业生产的水资源利用情况

中国水利部发布的2022年《中国水资源公报》显示：全国水资源总量为27088.1亿m^3，比多年平均值偏少1.9%，全国用水总量为5998.2亿m^3。其中，农业用水为3781.3亿m^3，占用水总量的63.0%。据预测，在2030年左右，我国人口或将达到16亿，届时，随着粮食需求的日益增长，农业用水总量的攀升也在预料之中。此外，根据中国发布的《第三次气候变化国家评估报告》，到21世纪末中国可能增温1.3-5.0℃。按照有关研究，温度每升高1℃农业灌溉需水量增加10%计算[3]，我国农业灌溉供需水矛盾将进一步加剧。

诚如中国生物多样性保护与绿色发展基金会（简称“中国绿发会”）副理事长兼秘书长周晋峰博士所述：工业文明造成的当前生物多样性危机与气候危机中，“水”的因素扮演着极端重要的角色[4]。近几年，随着水资源紧张情况的加剧，为了满足农业用水需求，加大了水资源开发力度，特别是受全球气候变化和高强度人类活动的共同影响，农业可利用水资源愈发有限，灌溉用水面临着严峻形势之下，水安全才能确保粮食安全已获得广泛共识。

农业用水主要来源为自然降水和人工补给用水两个方面。其中，自然降水是指未经过人工辅助而直接利用的天然降水。因受地域、气象和降水周期等不确定性因素的影响，这部分用水并没有做相关的数据统计。人工补给用水，则主要来自于对河流、湖泊、水库、地下水层等的提取，用于农业灌溉，这部分农业用水有着严格的统计与核查。

我国水资源禀赋差、耕地亩均水资源量不足、水土资源匹配错位，导致农业发展对灌溉水—即人工补给用水的依赖性较大。灌溉水主要包括漫灌、喷灌、微喷灌、滴灌、渗灌、调亏灌溉等不同方式。其中漫灌是指通过让水在地面上自由漫流，利用重力作用来浸润土壤。这种方式被称为粗放的灌溉方式，不仅灌溉效率低，也会浪费大量的水资源。在气候变化

叠加资源过度开发利用的双重因素影响之下，也对农业用水效率提升与可持续利用提出了更高的要求。

2021年11月，国家发展改革委、水利部、住房城乡建设部、工业和信息化部、农业农村部等部委联合印发《“十四五”节水型社会建设规划》（以下简称《规划》），《规划》提出“十四五”期间，全国新增高效节水灌溉面积0.6亿亩，创建200个节水型灌区，并提出到2025年，农田灌溉水有效利用系数提高到0.58，基本补齐节水设施短板和监管能力弱项，水资源利用效率和效益大幅提高。这也为我国全面推进高效节水农业发展，切实提高农业用水效率设定了具体的标准。

四、以沙产业为例，探索形成水资源高效利用的“新质生产力”

第六次产业革命理论由享誉世界的杰出科学家钱学森所提出，它被认为是在干旱荒漠地区实现农业现代化实践基础的一项伟大的科学预见。钱学森认为：第六次产业革命是以阳光为能源，通过光合作用进行产品生产的知识密集、技术密集的农业型的产业体系出现为标志，其产业类型可为林产业、农产业、草产业、海产业和沙产业，并认为，沙产业虽然是这些产业类型中的“小弟弟”，但其发展会走在其他类型的前面，并对沙产业任务作了重要诠释，即“变干旱不毛之地为沃土”。他也把“多采光，少用水，新技术，高效益”作为沙产业的12字技术守则[5]。

（一）荒滩上的沙产业示范带——新型现代绿洲

甘肃省张掖市山丹县在1994年率先以沙产业理念为指导，在古明长城沿线312国道的两侧戈壁滩不毛之地上，筹划并开始建设总面积为352平方千米的沙产业示范带。按照沙产业技术路径的“多采光、少用水、新技术、高效益”12字技术守则要求，修建塑料日光暖棚235座。以机井为水源井水入棚内进行节水膜下滴灌、渗灌，温室内以无土栽培和换基土模式进行精细蔬菜种植。采用雨水集流办法，在当地年降水量不足200毫米，但雨量集中在夏季（占80%降水量）并多以暴雨型、阵雨型出现的特点下，以汇集雨水为水源并将其引入大棚进行节水膜下滴灌。采用节水灌溉发展的日光温室，水的利用率可提高4倍，单井产值可增至40倍。依托这一技术路径，在戈壁滩不毛之地上涌现出集群式的日光温室区，形成沙产业理念指导下的“新型现代绿洲”的雏形[6]。

（二）甘肃河西走廊武威市的沙产业实践

进入21世纪以后，甘肃河西走廊武威市开始认识到，如大水漫灌的农业耕种方式，农业用水量过大，水资源控制薄弱，单位水资源效益不高。沙产业理念和其技术方案成为应运而至的破解武威农业产业开发与环境资源间矛盾的治本之策。石羊河是甘肃省武威市、金昌市两大干旱地区的主要工农用水源。自2003年起，按照沙产业理念，石羊河流域的农区着力发展多采光、节约用水的设施农业，从简易的地膜覆盖到人工控制生境的日光温室大棚，将人均占有水量集约使用在日光大棚内，单位面积耗水量最少且经济效益最高[7]。

下图为日光温室单位耗水量和单位面积效益对比：

表1 单位面积耗水量对比（以民勤县为例）

种植方式	日光温室	玉米、小麦套种	大田玉米	大田小麦
比例	100	760	480	400

表2 单位面积效益对比（以民勤县为例）

种植方式	日光温室	玉米、小麦套种	大田玉米	大田小麦
比例	3900	203	102	100

2008年开始，武威市依托日光温室生产出瓜果蔬菜共60.6万吨，行销到北京、上海等地，优质的瓜果蔬菜已进入邻国。至2015年，戈壁滩上日光温室培育的红提葡萄一亩年收入2.5万～3.5元，相当于旱地小麦的100倍。

由以上案例可以看出，沙产业的重要特征是知识密集型农业，是运用大量的现代知识，包括理论知识和技术知识来从事农业生产的产业。认识并践行沙产业，能帮助人们辩证地认识干旱半干旱地区的自然条件，正确理解如何合理开发利用水资源。这种策略思想的树立，对于我们这个人口众多、资源相对匮乏的国家，更有实际意义。

然而，沙产业概念虽然很早就被提出，但直到今天，这一理念并未得到全面普及和广泛应用。关于沙产业的认识和践行虽已初见成效，却仍任重道远。

2024年1月31日，习近平总书记在中共中央政治局第十一次集体

学习时强调，加快发展新质生产力，扎实推进高质量发展。与绿色发展关联契合后，新质生产力就是绿色生产力，加快绿色发展转型，坚持生态优先，助力碳达峰、碳中和也是加快形成新质生产力的呈现方式和实践路径。

1994年，为了推动我国沙产业的发展，钱学森支持创办了促进沙产业发展基金。2014年，中国生物多样性保护与绿色发展基金会接过了沙产业专项基金的光荣使命。在全社会加快形成新质生产力的大趋势影响下，继续沿着钱老第六次产业革命理论的方向，深刻把握沙产业的概念内涵和技术路径，并以此指导，开辟多元化的实践路径，扶持和推广关于沙产业的新思维、新方法与新模式和新样板，以探索形成水资源高效利用的“新质生产力”。

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春天里的植物精灵

安勤勤　霍岱珊　秦秀芳　杨晓红

摘要：新色是春天的主角，万物生机勃勃，繁花诠释着对大地的情谊，带上发现植物精灵的眼睛，来欣赏春天里的植物精灵。本文介绍了五种春天里的植物，包括嫩黄带绒毛的结香、蓝色的阿拉伯婆婆纳、重瓣粉色的美人梅、紫色成串的紫荆以及外形与芹菜相似的石龙芮，以飨读者。

关键词：春天，植物，结香，阿拉伯婆婆纳，美人梅，紫荆，石龙芮

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一、结香

结香属于落叶灌木，开花早，多被栽植在公园、路旁等，人们匆匆过往，很容易忽略它。若停下来，远看，黄白相间的颜色，毛绒绒的花球，虽不是人们口中的“花中贵妇”，但只要靠近它，一阵芳香扑面而来，几十朵小黄花“团结”成的绒球随之映入眼帘。有香、有色，处处散发着贵气。

结香花似乎也知道自己的与众不同，总是控制不住展示自己的心情，早早地将自己的绿色半绒球状花骨朵挂在枝头。冬末，春天的信息刚到，它便先开花后长叶，有时冒着雪，也要开。轻抚一下它的枝条，柔软、坚

韧，很容易打成结。也因此，结香还有“打结花”、“打结树”等这样非常简单直接的名字。

结香的传说故事更是让人浮想联翩。传说，如果两个相爱的人在结香枝上打结许愿，长久而幸福的爱情愿望就会实现。因此，在中国，结香被称作爱情树，有“喜结连枝”的象征意义。

结香花期在冬末春初，果期在春夏间，在我国的河南、陕西及长江流域以南各个省都可以看到。立春没过多久，河南一地的结香已经含苞待放了。

二、阿拉伯婆婆纳

走在路上，我们经常看到不起眼的小花朵。它们虽渺小，却也很美丽。成片地铺在大地上，给春天带来了不一样的清新。走近其中的一种——阿拉伯婆婆纳。相信很多人听到这个名字并不知道它长什么样，但如果放上图，就会恍然大悟。

没错，大家经常见到的这种开蓝色小花的植物，就是阿拉伯婆婆纳，玄参科婆婆纳属植物。阿拉伯婆婆纳的花，远看并不能吸引人的眼球，但只要俯下身仔细观察，精致感扑面而来：一朵朵蓝紫色的小花点缀在绿色的地毯上，每个花瓣上又具有明显的紫色纹路，从白色底部延伸出来，围在花中央的，是两个对望的雄花蕊，可爱又美丽。

与阿拉伯婆婆纳长得非常相似的是婆婆纳。区别在于，阿拉伯婆婆纳比婆婆纳高，且花梗明显长于苞片（或称苞叶）；婆婆纳的花朵色彩丰富，有紫色、粉色和白颜色，看起来较小，而阿拉伯婆婆纳主要为深蓝色；阿拉伯婆婆纳蒴果表面明显具网脉，凹口大于 90 度角，裂片顶端钝而不浑圆。

三、美人梅

美人梅，正如它的名字，是一种很美的观赏植物。由法国人于1895年在法国以红叶李与重瓣宫粉型梅花杂交后选育而成的。1987年2月从美国引入到中国。

美人梅属于蔷薇科梅属，为落叶灌木或小乔木。由于花瓣层层疏叠，瓣边又呈波浪起伏状，粉红色的花朵密密麻麻地挤在一起，整体看起来十分优美，因此备受人们喜爱。

因为具有很强的适应能力，耐旱、耐寒、耐高温，美人梅已遍布我国大江南北，在庭院、园林等绿化中占据了一席之地。值得一提的是，不仅它的花让人着迷，连它的枝条、叶片也让人忍不住多看两眼。因为它们的枝条和叶片为紫红色，不在花期的美人梅，它们本身就是一道非常美丽的风景线。

2024年3月，笔者拍到了盛花期的美人梅。枝头上挂满了粉红色的花朵，星星点点的花蕊填满了整个花心，仔细看，无法用语言来形容它的美，只能说一句：“太好看了！”

四、紫荆花

三月中下旬，正是紫荆花开时。紫荆是先花后叶的植物，花朵与其他开花植物差别较大，在万木丛中，并不难认出它。

只要你看见一簇簇紫红色的小花串满了光秃秃的枝干上，就像人为设计好的一样，那大概率就是紫荆了。

紫荆原产于我国，是豆科紫荆属丛生或单生灌木，又叫裸枝树、紫珠。也正是紫荆天生的“与众不同”，它被广为栽培，在从北至南的庭院、公园、校园等，都能看到它们的身影。

开花季节，很多人一眼就能认出它们，但是花谢后换了“衣裳”的紫荆却不一定有人能认得。换上绿装的紫荆也很有特色，叶片为“近圆形或三角状圆形”，但笔者看更像饱满圆润的心形。仔细看，同它的花一样，也十分具有美感。8-10 月份是紫荆的果期，与其他豆科植物一样，它们果为荚果。成熟后的荚果一个个挂在枝干上，等待落地生根的机会。

与其他广为栽培的植物一样，紫荆也被人们赋予了美好的寓意，象征着家庭美满、骨肉情深。

五、石龙芮

野草是生态系统中不可缺少的一部分，对生物多样性也具有重要的影响。走进野草，认识它们，可以增长我们的知识，丰富我们的生活。笔者在河南当地拍到了一种长相酷似芹菜的植物，有人叫它“野芹菜”。但它跟我们吃的芹菜、野芹菜，却有着天壤之别。

我们吃的芹菜是伞形科植物，在很早以前，芹菜就被人们广泛种植作为蔬菜食用；而石龙芮是毛茛科毛茛属植物，常生长在河沟边或湿地中。石龙芮全草含原白头翁素，有毒，一般不能食用。但也有人误把它们当芹菜采回家食用，导致中毒反应，甚至丢掉性命。

这种植物在河南当地是冬季为数不多的能够顽强生长、保持绿色的植物，远看，绿油油的一片，十分显眼。但生活在湿地中的黑水鸡，尽管冬季缺少食物，也不以石龙芮为食。它们似乎早就对这种植物有着深刻的认识，代代相传，保护了自身种群的健康。

那么在野外时，我们应该如何分辨石龙芮和芹菜呢？首先，在气味上就有所不同，芹菜散发着一种特殊香味，而石龙芮没有；另外，石龙芮的植株比较小，开花比较早，花是黄色的，而芹菜的花是白色的，这点上它们区别较大。大家在采摘野菜的时候，一定要辨认好，避免误食后中毒。

春季正值野菜大量上市的时期，建议大家对不熟悉的野菜，不要采摘，避免误食有毒野菜；在食用野菜后如有不适，应及时催吐，并携带剩余野菜和呕吐物就近就医。

《人类的未来——从全球文明到伟大文明》：对“可持续生存和发展”的深刻解读

王静　周晋峰

摘要：《人类的未来——从全球文明到伟大文明》一书探讨了人类面临的多重危机，包括地缘政治冲突、气候变化、资源枯竭等，以及长远的科技、进化、文明等深层危机。这些危机根源于工业文明模式，对人类生存和发展构成严峻挑战。该书作者对人类未来所面临的严峻挑战提出了科学严谨的解决方案与路径，强调以“人的心理、思维、认知和人的行为”为载体的软技术在伟大文明实现中的重要性。

关键词：人类文明，工业文明，生态危机，软技术

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这是笔者目前为止写得最艰难的一篇推荐序。原因无他，只是感觉自己难以用恰当的语言来简练介绍这本看起来不厚、设计简单的书——它看起来平平无奇，实际却包罗万象。

拍摄：Tammy

人类的未来会怎样？这是自人类文明诞生以来，始终被不断思考并探索，并且不断有学者从各个领域尝试解答的一个问题。

作为《人类的未来——从全球文明到伟大文明》一书的作者，中国社会科学院研究员、“全球未来展望组织”（MP）中国分部主席金周英用八个篇章，对“人类的未来”从文明的角度给出了自己的思考。

正如在开篇导言“人类走向哪里？”中，作者毫不客气的将人类所

面临的时代危机，尖锐鲜明且直截了当的摊开在读者眼前一样，在书中，作者从战略角度将人类面临的多种危机系统的分为两大类：一类是当前困境，如地缘政治冲突，气候异常变化，贫富差距加大，自然资源枯竭，生态环境危机，滥用技术（诸如对AI，纳米，生物技术等的创新方向失控），不断升级的地区战争和暴力以及微塑料、新病毒等各种影响人类可持续发展的现实危机；另一类是长远威胁，诸如科学技术危机、物种灭绝危机、人类进化方向危机、传统人类灭绝危机、地球毁灭危机和人类文明危机等深层危机。

对于这些危机的产生，作者亦一针见血地指出——上述危机的共同根源之绝大部分在于人类的发展模式，这些危机是工业文明所带来的深层次、结构性、社会文化和制度性的危机，使得人类连同赖以生存的地球上的生物遇到了严峻的可持续发展的挑战。正因如此，作者认为第二类危机，看似是长远未来的问题，对当前影响不大，但是如果不从现在开始着手解决，人类将面临灭顶之灾。

作者同样忧虑于，即便有识之士已经认识到了这些危机，但针对深层危机特别是人类长远未来的课题，目前主要是科学家、未来学家的探索，而公众对此的认知，则往往来自于科幻影视作品——真实的、科学的情况容易被高度娱乐化的内容所误导，而这可能是公共领域未来研究所面临的严峻挑战。

令笔者尤为感叹的是，作者虽然忧虑于人类未来所面临挑战的严峻性，但同样也给出了科学严谨的解决方案与路径。

“我们需要怎样的未来？”

“我们应该创造什么样的未来？”

“怎样才能使人类可持续生存和发展？”

我们姑且用这三个递进的问题，作为以阅读理解作者字里行间磅礴信息的一条引线吧！对于公众来讲，这可能并不是一条像通俗文学一样轻松的阅读之路，但作者以扎实的基础性研究，非常“硬核”的为大家构建起了人类文明所能达到的一种新的高度，比如“全球文明到伟大文明”，是一本涉及广泛、严谨且通俗的科普书籍。

令笔者印象尤为深刻的是作者对于技术的全面分析与解读。特别是在第三章“技术是什么？”中，关于软技术的阐述。作者认为，在技术不断创新加持人类发展的过程中，不论

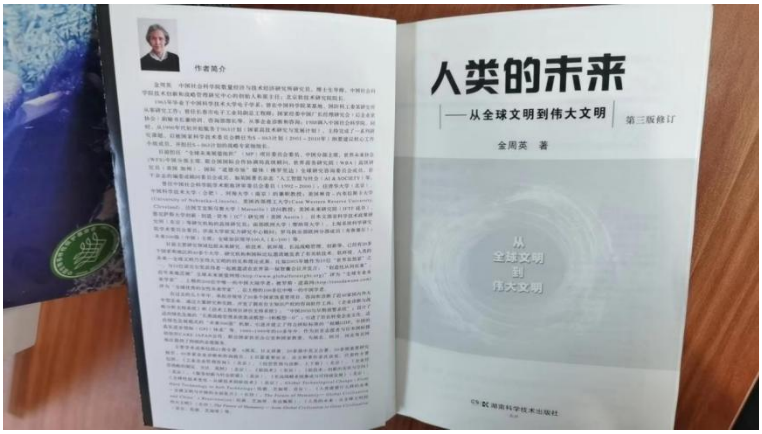
是技术崇拜症还是技术恐惧症，其中所指的技术，都是“硬技术”——以“物”为载体，只是多来自自然科学的可操作性知识体系；而软技术则是以“人的心理、思维、认知和人的行为”为载体，其知识来自非自然科学以及非（传统）科学的可操作性知识体系——是和硬技术一样悠久，但却长期被忽视的“技术的另一个范式”。

科技发展迅猛，硬技术革命的周期也越来越短。以观念和思维指导的软技术也变得越来越重要。因为有了软技术的支撑，伟大文明的实现便有了科学且系统的支撑。

也许很多人认为，工业文明仍然强悍且固执的影响着人类社会的运行模式，与之对比，生态文明显得羸弱可欺，全球文明乃至伟大文明看起来似乎距离我们太过遥远。这的确是当前的现状。但作为关注人类未来的一本科学书籍，作者需要给出的是基于现状的可实现的解决方案。很显然，作者做到了。所以，这是一本了不起的著作。

远大的目标，往往更具方向性和引领性，也可以让我们的探索更加坚定。

作为一名普通读者的一家之言，谨以此文，致敬作者。希望好书能与更多人共享。



拍摄：Tammy

附作者简介：

金周英，毕业于中国科学技术大学电子学系，中国社会科学院研究员，博士生导师，中国社科院技术创新和战略管理研究中心创始人和原主任。现为北京软技术研究院院长，“全球未来展望组织”（MP）计划委员会委员、中国分部主席，世界未来协会（WFS）中国分部主席，世界商务研究院（WBA）高级研究员（美国加州）等。曾在中国科学院***基地、国防科工委某研究所从事国防科研工作；曾任国家经委中国厂长经理研究会（后企业家协会）副秘书长兼培训、咨询部部长，先后主持完成了近 40 家大中型企业的经营管理诊

断和咨询；曾被国家科委聘任为 S—863（2001—2010 年国家高技术研究与发展计划）纲要核心工作小组成员，并先后两期担任 S—863 战略专家组组长；早期的扶贫志愿者；曾被全球未来展望网络评为“全球专业未来学家”，是榜上 208 人中唯一的中国大陆学者；被罗斯·道森网评为“全球优秀的女性未来学家”，是榜上 100 余人中唯一的中国学者。

周晋峰，中国生物多样性保护与绿色发展基金会副理事长兼秘书长、罗马俱乐部执委，创新提出了“人本解决方案”理论、污染治理三公理、生态恢复“四原则”、邻里生物多样性保护（BCON）、“碳平等”理论等。

尊重自然演替的力量，做好湿地保护

周晋峰

摘要：基于应成都市郫都区生态环境局就云桥湿地申报“生物多样性保护与绿色发展示范基地”赴实地开展的调研，本文探讨了“对云桥湿地而言，做好水源地保护”这一重要目标以及与保护目标产生偏差后人工干预的尺度，进而讨论了“外来入侵物种”这一问题，例如水葫芦、福寿螺、加拿大一枝黄花、互花米草等。本文强调，对外来入侵物种的治理，也应该看它们对我们的主要保护目标是否构成威胁，如果不构成威胁，那么自然的伟大远超过我们人类。

关键词：湿地，外来入侵物种，人工干预，自然

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2024年4月28日，应成都市郫都区生态环境局就云桥湿地申报“生物多样性保护与绿色发展示范基地”，笔者一行赴实地调研并做湿地保护主题交流。交流内容如下：

对云桥湿地而言，做好水源地保护，这是非常重要的目标。如果对水源地保护有比较大的偏差，我们需要人为干预并进行调整，如果没有对水源地保护的目标产生重大影响，我们则不该为了追求种类多而进行过多的人工干预。

人工干预的尺度是什么？就是我们目标。我们保护是为了生存和发展，生存和发展赋予这一块土地的职责就是要保护好水源地。终极的目标是保障水源，与之相关的物种演替的速度、种类的多少，我们要尽量尊重自然。

大家往往对外来入侵物种很敏感，比如水葫芦、福寿螺等。要知道地球自有生命以来，就存在着生命的迁徙。其中有些物种的迁徙严重的影响了本地物种的生存，形成入侵并对我们要保护的主要目标形成干扰，这种情况之下，人们需要去清理和干预；

如果对我们的主要目标没有形成干扰，我们认为可以让自然去调理。

比如福寿螺，我们发现在国内，乌龟也开始吃它了，原来是不吃的，这是自然演替的适应性变化。自然的演替和全球的生物迁徙，自有生命以来就存在。包括互花米草，很多人认为是个要命的事儿，天津一地区为了治理互花米草把河滩都挖了一米，草、根都捞出来，让它长不成，但我们同时也观测到那个海滩本来每年都有近万只国家一级保护动物遗鸥去觅食，通过这种方式的治理，则只观测倒五十几只了，这与人们捞泥滩防治互花米草有一定关系，因为泥滩里没吃的了，遗鸥也就不来了，相当于它们的的栖息地受损了。

比如加拿大一枝黄花，有人举报说大连某植物园有加拿大一枝黄花，那是外来入侵物种，必须要消灭掉。而有科学家则说这都种了好多年了，从来没对本地环境造成任何负面影响和冲击，为什么要灭掉呢？可见，对外来入侵物种的治理，也应该看它们对我们的主要保护目标是否构成威胁，如果不构成威胁，那么自然的伟大远超过我们人类。

笔者去广西北海调研湿地，有科学家介绍那里的红树林工程，说原来那个地方总不长红树林，于是科研人员用很粗的塑料管，先在苗圃里种红树林，然后移到海滩上，第一年种下去有一半死了，存活率一半，第二年继续补种一半，成活率又是一半，整体成活有 75%，觉得是征服了自然、改变了自然。笔者认为这种做法并不可取，那个地方本身就不长红树林，那么我们应该尊重本土的生态自然。

很多物种，包括我们吃的辣椒，还有前面提到的互花米草，都是外来引进的，只要它不影响我们的保护目标，建议人们就别下大功夫治理，笔者认为这应该是是否采取人为干预措施以及干预到什么程度的一个标准。充分尊重自然的演替过程，我们需要改变我们的观念。

比如我们倡议“让野草长”，人工草皮是工业化的商品，而不是自然生态的一部分，野草才是自然生态。我们呼吁了多年，北京现在有些地区接受了这个意见，开始让野草去长，尊重自然的力量。这是一个很好的改变。

征稿简讯（十五）

《生绿》2024年7月刊聚焦“生态恢复四原则”

完整且有弹性的生态系统确保了地球的健康运转，但人类活动正在导致前所未有的环境变化，给自然世界带来负担。令人担忧的是，据估计，在地球上，只有不到3%的陆地生态系统保持完好，97%以上的土地都已不再符合生态完整的标准。当前预防、制止和扭转自然丧失已成为全球优先事项，联合国大会宣布2021-2030年为联合国生态系统恢复十年。恢复生态学正在成为帮助恢复受损生态系统以及解决生物多样性危机的关键科学。

生态恢复是对生态系统停止人为干扰，以减轻负荷压力，依靠生态系统的自我调节能力与组织能力使其向有序的方向进行演化，或者利用生态系统的这种自我恢复能力，辅以人工措施，使遭到破坏的生态系统逐步恢复或使生态系统向良性循环方向发展。在科学有效的生态恢复中，应该坚持生态恢复四原则，即节约原则、自然原则、有限原则和系统原则，由中国生物多样性保护与绿色发展基金会副理事长兼秘书长周晋峰博士结合团队实际工作经验提出。

《生物多样性保护与绿色发展》（简称《生绿》）7月刊将聚焦“生态恢复四原则”，欢迎社会各界投稿。征稿截止日期为7月15日。投稿方式及征文规范详见：生物多样性保护与绿色发展。

此次征稿的分主题包括但不限于：

1. 生态恢复四原则的理论研究；
2. 生态恢复四原则指导下的实践；
3. 气候变化如何影响生态恢复；
4. 生态恢复项目成效评估标准；
5. 公民科学和社区主导的生态恢复。

（注：鼓励投稿时附有相关清晰图片）

翠菊
图源：绿会融媒

China Aster (*Callistephus chinensis*)
Photo source: CBCGDF Media

In Focus: Invasive alien species and biodiversity

Biodiversity is vital to the processes that support all life forms on the Earth, underpinning human well-being now and into the future. Humans depend on biodiversity in many ways. Pollinators such as birds, bees and other insects are estimated to contribute one-third of global crop production. Agriculture also relies on invertebrates, which help maintain the health of the soil needed for crop growth. Microorganisms in the soil are essential for releasing the nutrients for the growth of plants, and these nutrients are ultimately passed to humans through the food chain...... Therefore, protecting biodiversity is of great significance to us.

Over the past few decades, scientific research has extensively documented the negative impacts of human-induced global change on biomes, human health, and economies. An increasing number of studies have proven that global change factors do not act independently, but are intertwined in complex interactions. For example, the spread of invasive species has become a devastating hallmark of the Anthropocene. Driven by globalized trade and travel, invasive species rapidly take root in ports of entry, and the polluted and degraded environments further promote their spread. In this context, the characteristics that contribute to successful invasions not only need to be studied and potential regulatory mechanisms proposed accordingly, and these mechanisms must also be considered within a broader framework of global change and translated into practical actions.

On 19 December 2023, the one-year anniversary of the adoption of the Kunming-Montreal Global Biodiversity Framework, the Secretariat of the Convention on Biological Diversity launched “The Biodiversity Plan” campaign, aiming to communicate and promote the 4 Goals and the 23 Targets of the Framework to the world. Among the 23 Targets to be achieved by 2030, they include “preventing the introduction and establishment of priority invasive alien species, reducing the rates of introduction and establishment of other known or potential invasive alien species by at least 50 per cent”. May 22, 2024 is the 24th International Day for Biological Diversity, themed “Be part of the Plan”.

This month's journal focuses on the series of topics related to invasive alien species and biodiversity and discusses with readers the hazards of these species and possible countermeasures.

Research on the harm and response strategies of invasive alien species

By WEI Qi, YANG Honglan

Abstract: Ecological security, same with political security, military security and economic security, are all security fields that concern the overall situation and have a significant impact on national security. The invasive alien species has posed a major threat to the global ecology. As a result, the study of alien species invasion is an important aspect of research in the field of ecological security. This article discusses the harm of invasive alien species and proposes effective response strategies. By analyzing the negative impacts of invasive alien species on biodiversity, ecological environment and human health, the article proposes response strategies from the aspects of monitoring and early warning, international cooperation, publicity and education, biological control and species management, in order to provide ecological security planning and certain reference for deployment.

Key words: Invasive alien species, biodiversity, ecological security

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Native Salmonids and Salmon Aquaculture in China

By WEN Bo

Abstract: There are about 14 species of native salmonids in China. Pacific salmon populations in the rivers of Northeast China have been greatly reduced. Landlocked salmonids are found in the China including Sichuan taimen, Qinling Lenok and Formosan salmon, all of which are endangered species. Transboundary species such as Xinjiang Inconnu and Korean taimen are in urgent need of conservation. China's salmon farms have introduced a large number of exotic salmonids for breeding and rearing, and their environmental impacts on the native ecosystems of local rivers, lakes and coastal seas need to be paid attention to.

Key words: Native salmonids, salmon farming, exotic species

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Introduction

Salmon is the common name for a variety of fish in the family Salmonidae. Salmon live in the oceans at high latitudes or in cold rivers at high altitudes. They are typically migratory fish, with juvenile salmon swimming to the ocean in the spring and adults returning to the rivers to spawn in the fall. Some salmon are land-locked species.

Several decades ago, Atlantic salmons were introduced to Guangdong via Hong Kong. The English word "salmon" is pronounced "sanwen" in Cantonese, and the name then spread throughout China. As a result, salmon originally referred only to Atlantic salmons, but now includes a variety of salmon species such as Pacific salmons and trouts.

Nowadays most China's imported salmon comes from Norway and Chile. As the market has exploded and demand has outstripped supply, many other salmons and trouts have been classified as “sanwenyu” and marketed under various subcategories. Although there are farmed salmon and wild salmon on the market that live in different waters and have different appearances and flesh colors, they are all considered “sanwenyu” in China. Therefore, the term “sanwenyu” is more of a commercial concept than a strictly scientific one.

In the northeast China, Pacific salmon are known as “Damahayu”. The name is derived from the Hezhen language of Heilongjiang Province.

1. Native Wild Salmonids Species in China

There are about 14 species of salmonids in China, accounting for more than 20% of the world’s salmonids, including Masu salmon (including landlocked), Humpback salmon, Chum salmon, Korean taimen, Siberian taimen, Lenok, Mountain trout, Dolly Varden, Inconnu, Amur whitefish and various trouts.

1.1 Pacific Salmon in the Northeast China

Three species of Pacific salmon, Masu salmon (*Oncorhynchus masou*), Humpback salmon (*Oncorhynchus gorbuscha*) and Chum salmon (*Oncorhynchus keta*) have been found in rivers flowing into the Pacific Ocean in Northeast China. Historically, the spawning grounds of these Pacific salmon in China include the Heilongjiang, Ussuri, Suifen, Songhua, Mudan, and Tumen Rivers, with anadromous populations in the Songhua and Mudan Rivers that have not been seen for many years.

Masu salmon are most abundant in the Ussuri River in Heilongjiang, and can also be found in the Tumen, Hunchun, Mi, Suifen, and Nen Rivers, as well as a landlocked subspecies known as the Formosan salmon in the Shei-Pa National Park of Taiwan. A small number of individuals of Masu salmon were also found in the Yellow Sea in 1976.

Pacific salmon that migrate to Fuyuan County in the fall migrate from the Sea of Okhotsk through the Heilongjiang River in Russia to China from early to mid-September to late October each year. In Fuyuan County, salmon are divided into

Heilongjiang salmon and Ussuri salmon based on river basin they are found. There are spawning grounds for Pacific salmon in the nature reserves of the Heilongjiang, Ussuri and Songhua rivers. However, overfishing in Fuyuan County over the years has led to a decline in these salmon populations. In addition, Pacific salmon in Fuyuan County have become smaller in size and tend to mature at a younger age.

Pacific salmon distributed in China have shown a significant downward trend in their populations, with the main factors being overfishing, dam projects and river pollution. Historical harvests of Pacific salmon in the northeast China were: The average harvest from 1947-1949 was 306,000; 1950-1969 was 372,000; 1970-1979 was 188,000; 1980-1989 was 214,000; and 1990-1999 averaged 45,000. From 2000 to 2004, the average harvest was only 19,000 tails.

Salmon in the Tumen River used to be abundant, but due to the deterioration of the fishery ecosystem, pollution of the river water and uncontrolled overfishing, salmon stocks collapsed and catch dropped to one-tenth of its original level. In 2004, the results of a study to characterize the structure of the breeding population of salmon in the Ussuri River showed that individual lengths and weights of the population have become significantly smaller than they used to be. The population is currently endangered and in urgent need of protection.

1.2 Sichuan Taimen

Sichuan Taimen (*Hucho bleekeri*) is endemic to the Yangtze River basin in China, distributed in the upper tributaries of the Yangtze River in Sichuan Province, the middle and upper reaches of the Dadu River in Sichuan and Qinghai Provinces, and the upper reaches and tributaries of the Han River, south of the Qinling Mountains in Shaanxi Province. It lives mainly in fast-flowing streams with sandy and gravelly substrates. Due to habitat loss and illegal fishing, the population of this particular fish is seriously threatened and has been listed as “critically endangered” by the International Union for Conservation of Nature (IUCN).

1.3 Lenok

The species and subspecies of the genus Brcahymystax remain scientifically undetermined. It was discovered in 1930 and named Tumen lenok (*Brachymystax tumensis*). In 1966. Li Sizhong discovered lenok in the Qinling region and named it Qinling Lenok (*Brachymystax tsinlingensis*) However, this species was already discovered in ancient China and was caught and offered to the royal family as a tribute fish. It is mainly found in rivers originated from the Qinling Mountains. Qinling lenok, like Sichuan taimen, are typical of landlocked populations of cold water fish formed during the Quaternary glacial period. Qinling lenok is currently found in Shaanxi Province and Gansu Province which both have designated nature reserves for conservation of the species.

1.4 Inconnu

Inconnu (*Stenodus leucichthys*) is mainly found in the Irtysh River and the Burjin River in Xijiang. In the early 1960s, due to overfishing, the production of this fish gradually decline. In the 1980s, it was on the verge of extinction in China. Climate change has led to sever drought at the Irtysh River basin. The river has been lack of water, especially in the fall when spawning occurs. Another reason is that the Kazakh agricultural irrigation in the Irtysh River, and a diversion canal was opened in the middle and lower reaches of the river, resulting in the flow into the Ebi River (i.e. the Irtysh River) was reduced and fish were unable to spawn anadromously.

1.5 Dolly Varden trout

Dolly varden trout (*Salvelinus malma Walbaum*) has landlocked type and anadromous type. In China, Dolly Varden trout is a landlocked species, distributed in upstream tributaries of the Yalu, the Tumen and the Suifen river basins.

1.6 Korean taimen

Korean taimen (*Hucho ishikawae*) is found only in the upper Yalu River and its mountain streams in China and is endemic to Jilin Province.

With the significant development of industry, agriculture and fishing in the area, the increase in human population, construction of hydro projects, discharge of sewage, Korean taimen has been severely affected. Only 14 Korean taimen were collected in a large-scale fish survey in Jilin Provice in 1980-1984, and only 2 Korean taimen were collected in the upper tributaries of the Yalu River in 1994-1997, and then no Korean taimen were recorded since. Although some scientists proposed artificial breeding and the establishment of stocking stations in the 1990s, and by the time the Jilin Upper Yalu River National Nature Reserve was established to protect these coldwater fish, it was too late.

1.7 Formosan salmon

Formosan salmon (*Oncorhynchus masou formosanus*), also known as Formosan landlocked salmon, is the southernmost subspecies of Masu salmon and its population was once on the verge of extinction. It was once a staple food of Taiwan’s aboriginal people, but overfishing and dams led to a decline in its population, with only 200 left in 1992, according to official statistics. Now its native habitat is protected, and effective conservation efforts have allowed the population to recover to 12,587 fish in 2020. In March 2023, the Shei-Pa National Park counted 15,374 Formosan salmon, again setting a new high since the restoration program begun in 1995. Image of Formosan salmon is printed on the back of the NT$2,000 banknote issued by Taiwan’s central bank.

2. Salmon Farming and Introduction of Exotic Species

Salmon farms in China are located in Northeast China, Xinjiang, the Tibetan Plateau and the Yunnan-Guizhou Plateau regions, and salmon farming is also practiced in the Yellow Sea and the Bohai Sea. In addition, on Gaotang Island at Xiangshan County, Ningbo City, Zhejiang Province, a Danish company has invested in a land-based Atlantic salmon recirculation system, the first foreign-invested salmon farm in China.

2.1 Northeast China

Siberian taimen lives in China and other northeast Asian countries. It is also known as the “aquatic Siberian tiger” and is a vulnerable species on the IUCN Red List of Threatened Species. It is found in China, Kazakhstan, Mongolia and Russia. In China, it is found in the upper reaches of the Heilongjiang and Nenjiang Rivers, the Mudan River, the Ussuri River, the Songhua River, Jingpo Lake and the Irtysh River. In 2005, the Bohai Cold Water Fish Experimental Station of the Heilongjiang Institute of Fisheries Research successfully carried out artificial propagation and obtained artificially domesticated fish fry.

In 2003, the Shankou Reservoir in Wudalianchi City, Heilongjiang Province, introduced 425,000 fry of Russian origin Peled (*Coregonus peled*) from the Sayram Lake in Xinjiang, and again introduced fry from the Sayram Lake in 2006.

2.2 Xinjiang

Inconnu are found in the lower reaches of the main stem of the Irtysh River in Xinjiang, but the species has not been farmed in Xinjiang. Inconnu have been farmed in Sichuan Province instead.

Since the 1970s, Rainbow trout have been farmed in the Ili River basin for more than 40 years. Located in the upper reaches of the Ili River, Nilek County in Ili Kazak autonomous prefecture has three large and medium-sized reservoirs. The water temperature in the reservoir area is maintained at 8-13 degrees Celsius all year round, and the water quality is clear, which is suitable for the growth and reproduction of cold water fish and large-scale aquaculture. In early 2014, a salmon aquaculture base was built in waters at an altitude of more than 1,000 meters in Nilek County, opening up inland large-scale salmon aquaculture in Xinjiang.

In 1998, Russian Peled (*Coregonus peled*) and Arctic cisco (*Coregonus autumnalis*) were first introduced into Xinjiang’s Sayram Lake, which have now adapted to the local environment.

2.3 Qinghai-Tibetan Plateau

China's CCTV Finance reports that one-third of the salmon in China's domestic market comes from the Tibetan Plateau, produced in the Longyang Gorge at Gonghe County, Qinghai Province, upstream of the Yellow River, which is home to China's highest in altitude and largest salmon farm.

Qinghai Province: In 2003, Qinghai Province introduced fish species such as Peled from Russia to increase breeding in waters such as Longyangxia, Heiquan and Nanmenxia. Qinghai actively promoted locals to carry out cage aquaculture in the Longyang, Lijia, Gongbo gorges and other reservoirs. For the first time, Qinghai Province became the largest Peled producing area in China. At the same time, Qinghai has vigorously carried out Peled breeding program, established three Peled breeding bases and one breeding base in Datong and Nanmenxia, and cumulatively supplied nearly 5 million Peled fry to Xinjiang, Heilongjiang and other places.

Tibet Autonomous Region: The Yadong River is located in the southern foothills of the central Himalayas in Yadong County, Shigatse, Tibet, and is home to the Yadong trout (*Salmo trutta fario*), which is now a Class II protected species in Tibet. In the second half of the 19th century, the British introduced it from Europe to the southern foothills of the Himalayas. It was first introduced to northern India and then to the Yadong area of Tibet.

Yadong trout is one of the three treasures of Shigatse. Yadong County Eco-Industrial Park Salmon Farming Base has invested 242.17 million yuan to build breeding facilities and hire local farmers and herdsmen to farm Yadong trout.

2.4 Yunnan-Guizhou Plateau

There is a salmon aquaculture base in Hongkou Scenic Area, Longchi Town, Dujiangyan City, Sichuan Province. The salmon aquaculture base is built in the upper reaches of the Baisha River. Relying on Hongkou's alpine snowmelt water resources, the base farms golden trout (*Oncorhynchus aguabonita*), Rainbow trout

(Oncorhynchus mykiss), Tibetan Yadong trout, Arctic char (*Salvelinus alpinus*) and other fish.

In the Mayi River at Songhe Village, Dashan Township, Dafang County, Bijie City, Guizhou Province, a salmon aquaculture farm has been built by digging canals and drawing water from Karst caves to create a running water aquaculture habitat. Some of its salmon eggs come from Spain and the farm also include other fish such as Rainbow trout.

2.5 Salmon Farming in the Yellow Sea and the Bohai Sea

Since the 1970s, Chinese aquaculture experts have attempted to farm Atlantic salmon in the open waters of northern China, such as Qingdao, Dalian, and Yantai, all of which ended in failure.

Since May 2015, experts from the Ocean University of China and a local company began to experiment with farming salmon in the Yellow Sea. In 2017, called “Deep Blue 1”, a large-scale aquaculture metal equipment was put in the water to raise Rainbow trout and Atlantic salmon. This salmon farming practice faces many uncontrollable factors. Due to seawater corrosion, holes started to appear on metal cage, resulting in salmon escape in large numbers. Currently, “Deep Blue 2” is also in use.

Another institution engaged in Rainbow trout aquaculture in the Yellow Sea is the Heilongjiang Fisheries Research Institute of the Chinese Academy of Fisheries Sciences. The institute has implemented the “Shui Ke 1” Rainbow trout project in Mudanjiang City, Heilongjiang Province. The project provides more than 900,000 fry and adult Rainbow trout from the breeding base at Zhuanxin Lake in Ning’an City, China, and conducts sea salinity experiments. Since 2020, the institute has been gradually adapting Rainbow trout from freshwater to seawater by adjusting the water environment. It utilizes deep-sea cold water mass to expand the breeding area and realize the land-sea relay breeding mode of Rainbow trout. Its experiments exist respectively in Heilongjiang Province, the Yellow Sea region at Dalian and Yantai, as well as the Bohai Sea area in Dongying etc., using of Rainbow trout fry and adult fish, totaling more than 900,000 fish.

3. Conservation recommendations

3.1 Salmon farming causes water pollution.

Salmon farms allow fish excreta and food residues to fall directly into the aquatic ecosystems, resulting in the accumulation of excessive nutrients such as nitrogen and phosphorus in the surrounding water bodies, which can damage aquatic ecosystems and protozoan plant communities. In addition, the overuse of chemicals such as antibiotics, antifoulants and pesticides in salmon farming can have adverse effects on aquatic life and human health.

3.2 Fish welfare in salmon farming cannot be ignored.

Salmon in fish farms are confined in small spaces with very little room for each salmon to move. Overcrowded fish are more susceptible to disease and suffer more stress, aggression and physical injuries such as fin damage. In addition to lack of space, overcrowding can lead to poor water quality, which reduces the amount of oxygen the fish can breathe. Salmon are migratory fish that travel long distances in nature, and conditions in intensive salmon farms are unlikely to meet the basic needs of salmon.

3.3 Conservation of wild Salmonids species should be emphasized.

Most wild Salmonids fish populations in East Asia are threatened. Countries and regions can share conservation experiences and promote mutual learning and cooperation. For example, lessons can be learned from the conservation of Formosan salmon. At the same time, Salmonids fish research institutes and protected areas in Northeast Asian countries can work together to promote the conservation of wild Salmonids fish resources through site visits and exchanges, as well as international conferences. In addition, dialogue and exchange mechanisms can be established between Salmonids fish conservation organizations in China and North America.

(The author served as China Program Director of Pacific Environment.)

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The hidden risks behind raising "exotic pets"

By YANG Honglan, LI Lihong, WEI Qi

Abstract: Some pet lovers who pursue fashion, trendiness and novelty have broken the long-standing concept of raising traditional pets such as cats, dogs, birds and ornamental fish. They began to raise "exotic pets", such as aquatic pets, small mammals, insects, etc. These wildlife that people keep as pets may come from the wild or are the descendants of artificial breeding from wild sources, and often come from other countries and regions. Pet lovers smuggle them into one country through illegal means. These alien species may compete with domestic native organisms for resources and ecological niches, thereby destroying the local ecological balance. Some alien species are even highly toxic themselves or carry diseases, which pose potential risks and hazards to the domestic ecological environment and human health.

Key words: Exotic pets, biosecurity, alien species, illegal entry, ecological risks

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Why is a Global Plastic Regime Delayed?

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Abstract: The production and pollution of plastic started decades or even a hundred years ago. Since Rio+20 in 2012, the plastic pollution problem has been prominent in global environmental politics. Under the United Nations Environment Programme (UNEP) framework, states are negotiating an international plastic regime to end plastic pollution. The formation of the instrument still depends on the negotiations. This paper aims to answer why a multilateral environmental agreement (MEA) on plastic pollution is delayed through holistic retrospection of economic and political aspects, as well as the availability of substitutes to fossil-based plastics. This paper finds that 1) the process of understanding the urgency of the plastic pollution problem has taken decades to proceed; 2) plastic is ubiquitous in socioeconomic activities and the plastic industry is too impactful to be restrained through an MEA; 3) the absence of feasible, inexpensive, compatible, and carbon-friendly substitutes to fossil-based plastic; 4) states' positions on this issue are different; and 5) the complexity of international regime-making processes. These five factors together postponed the effective formation and implementation of the plastic MEA. The time and even whether when the plastic regime is effective in solving plastic pollution is beyond predictions.

Key words: Plastic pollution, multilateral environmental agreement (MEA), International Negotiating Committee (INC), global environmental governance, bioplastics

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1. Introduction

A world without plastics is nearly unimaginable nowadays. Modern industries are becoming increasingly involved with plastics in a wide range of applications such as packaging, construction, transport, healthcare, and electronics. For example, if you take apart a Boeing 787-10, you will be surprised to learn that 50% of this behemoth is made of plastic. According to Plastics Europe (2017), global plastics output has grown 20 times over the past half-century and is expected to double every two decades. This has been made possible by plastics' combination of low cost, versatility, lightweight durability, and material strength, which has brought significant economic benefits to the manufacturing and consumer goods industries.

While plastics have many valuable uses, the world has come to rely on single-use plastics, which have significant environmental, socioeconomic, and health costs. According to the UNEP (2023) data, people consume one million plastic bottles per minute and use up to five trillion plastic bags per year globally. Overall, half of all plastics produced are for single-use only, and technological breakthroughs in alternatives to plastics are too limited in the face of the sheer volume of plastic consumer goods to drive a green transition for plastics. Additionally, the decisive factors and tipping points for improving the status quo are still unpredictable. Plastics are flooding the natural environment. It is becoming part of the Earth's fossil record and a hallmark of the Anthropocene. Plastic has even been used to name a new marine microbial habitat called the "plastic interstice".

How do we step into this "trap" of plastic? When the problem of plastic emerged due to the commercialization of plastic 70 years ago, the problem was relatively manageable, and few people were aware of the potential hidden dangers. 50 years ago, plastic production and plastic waste generation more than tripled, and some scientists noticed marine plastic pollution, but the vast majority of policymakers and the public remained unaware of it. 20 years ago, the amount of plastic waste grew faster in a decade than it had in the previous 60 years, and the global plastics crisis was included in the United Nations sustainable development agenda only 10 years ago, with the concept of "microplastics" becoming well-known.

While the plastic crisis may seem like an unexpected challenge to global environmental governance, the cost of our delay in recognizing and acting on the problem, past, present, and future, will always be a heavy price to pay, unless we know "why it happened". The cost of the lack of plastic control will ultimately come in the form of huge economic costs from the reduced productivity of important natural systems such as oceans and seas, and the crowding out of space for urban infrastructure and other resource use.

This paper aims to systematically answer the question of "Why the Global Plastic Regime is Delayed" through 5 aspects. Firstly, starting with the process of understanding plastics, the article discusses the delay and stages involved in human understanding of plastics, in chronological order of the emergence of the plastics problem, and the evolution of the importance of relevant research and agendas in the natural sciences. Secondly, using the concept of "full life cycle" as a starting point, and through sorting out the industrial process and distribution of industries, we will elaborate on the wide range of plastics issues and the obstacles that contradict the goals of environmental management and economic benefits from an economic perspective. Thirdly, through the lens of material and industrial economics, we analyse the existing and potential alternatives to plastics and discuss the key impact of research results on alternatives and technological innovation on the plastics regime. With the understanding of the plastics issue, the final two aspects focus on international politics and international lawmaking perspectives to further discuss the obstacles to negotiation and gaming between different countries, intergovernmental organizations, and plastics industry interests in the development and implementation of international plastics governance contracts. In addition, the complexity of the process of signing a joint action in the form of an international treaty and confirming it through domestic legislation will be addressed.

2. Recognizing the Plastic Crisis

Plastic is a material that shares its fame with steel and cement. A cornerstone of modern industry, it has reshaped the world over a century and a half of development. If we want to understand why it is so difficult to control plastics, we need to look at the history of the birth and development of plastics, how we have learned about plastics and the pollution problems they cause. The impact of plastics has always been in the hidden corners of the world, much ahead of the awareness of its effects. History relates that in 1907, Belgian chemist Leo Hendrik Baekeland invented the first known synthetic plastic: Bakelite. Two years after he was the first researcher to use the word “plastic” to describe all products created from macromolecules (resins, elastomers, artificial fibres, among others). At the same time, Herms (1907) wrote what is probably the first scientific paper on beach debris. In the following 114 years, “there has been much water under the bridge” or, in this case, “many plastics have reached the coastal and marine environment”.

Today’s plastics, which we are accustomed to, have been largely established since the Second World War and have since moved towards large-scale production and commercial, civilian applications (Landrigan et al., 2023) . The accumulation and innovation of material technology and processing technology during the two world wars determined the future model of the plastics industry: using fossil fuels as raw materials, using plastic stamping technology to process, which soon made plastics popular in the civilian commodity market. Of course, this popularity was partly due to the low cost, plasticity, wear resistance and multi-purpose characteristics of plastics themselves. Later, as global production and use of plastics continued to expand, the environmental impacts of plastics as a “novelty” became apparent, but it took a long time for these impacts to be truly recognized. The understanding of plastics in the scientific field can be divided into three phases according to the time hierarchy.

Starting in the 1970s and continuing into the early 1990s, initial knowledge of the impacts of plastics on the environment was largely developed (Williams and Rangel-Buitrago, 2022). This period saw the beginning of systematic research in the fields of biology, ecology, and environmental sciences on the impacts of plastics on marine organisms and the marine environment, with relatively little reference to the scale and nature of the impacts.

Among the early systematic recognitions and references to marine plastic pollution, the most typical is the Great Pacific garbage patch. The patch was described in a 1988 paper published by the National Oceanic and Atmospheric Administration (NOAA). The description was based on research by several Alaska-based researchers in 1988 who measured neustonic plastic in the North Pacific Ocean and found relatively high concentrations of marine debris accumulating in regions governed by ocean currents. It was assumed that a similar situation would occur in other parts of the Pacific Ocean, where the prevailing currents favoured the formation of relatively stable waters. This is particularly true of the waters influenced by the North Pacific Gyre.

A voyager returning from the 1997 Trans-Pacific Race through the North Pacific Gyre claimed to have encountered a huge patch of floating rubbish. Moore alerted oceanographer Curtis Ebersmeyer, who subsequently named the area the “Eastern Garbage Patch”. The area is often reported in the media as a particular example of marine pollution.

The second stage began in the 1990s, when Thompson et al. (2004) from the University of Plymouth, United Kingdom, published a paper on plastic debris in marine waters and sediments in the journal *Science*, for the first time proposing the concept of “microplastics”, which refers to fragments of plastics and particles with a diameter of fewer than 5 millimetres. At that stage, there was a consensus in the scientific community that recognized the negative environmental impacts of plastics in general and their damaging effects on ecosystems and the marine environment. Attempts to assess the scale and modelling factors of this impact, including what we now know as the life cycle of plastics, began to be mentioned at this time (Fagan, 2019).

Since the interpretation of the microplastic problem in 2004, mankind has gained an accurate understanding of plastic pollution and the associated problems generated by plastics and has begun to focus on policy solutions to the problems posed by plastics and the search for reliable alternatives to plastics. The issue of plastics has not only returned to the materials science and chemistry agenda but has also expanded from the environmental sciences to the developmental, political, and legal sociological arenas.

The pandemic has changed the trends in plastic use in several ways in 2020, with two main opposing trends. On the one hand, there has been a significant increase in global demand for certain plastics applications. This is partly due to the demand for personal protective equipment (PPE), with the use of plastics for medical masks reaching approximately 300,000 tonnes. Similarly, the COVID-19 pandemic dramatically changed economic activity, with increased demand for takeaway food and e-commerce, which use large amounts of single-use plastics and plastic packaging. On the other hand, due to the reduction in overall economic activity during the pandemic, there is a subsequent decline in the use of plastics in other sectors, in particular wholesale and retail trade, automotive manufacturing, and construction, where there is a significant reduction in the use of plastics (Charles and Kimman Laurent, 2023) . By 2022, the use of plastics in these three sectors alone will be reduced by about 8.2 million tonnes.

After COVID-19, the global market has seen a resurgence in demand for plastic products (Landrigan et al., 2023) . It means that our concerns about plastics management cannot be focused solely on pollution. The scale of plastics production is so large that it permeates every aspect of our daily lives. Therefore in the next section, we will look at plastics from the point of view of the industrial production process of plastics products.

3. Understanding The Plastic Industry: From Cradle to Grave

Any management strategy used to tackle plastic pollution must begin with an understanding of underlying processes, in this case, the life cycle of plastics. A plastic bottle will serve to illustrate the situation, as it is a good example of throwaway living.

The life cycle of a plastic bottle begins with the extraction of crude oil or natural gas (the raw material) used to make polyethene terephthalate (PET), the main ingredient in plastics. The raw material is extracted through large-scale processes such as mining or fracking. In this process, 90% of the raw material is petroleum and heavy oil, and 1% is based on biomass. This type of processing means increased environmental costs. Worst of all, the impact of plastics is just beginning.

Moving raw materials from the source to the facility where the plastic is manufactured requires a complex transport and storage system. Millions of tonnes of plastic raw materials are transported every day through a variety of channels, and conventional modes of transport such as pipelines, ships, barges, trains, and tanker trucks are vulnerable to spills, explosions, collisions, groundings, and terrorist attacks. The raw material transport chain poses potential risks to the environment, public health, and safety. Some of these transport routes are regulated, such as ships and barges. And this is not a universal rule. Some transport pathways lack adequate monitoring and scrutiny, such as pipelines. According to the Pipeline and Hazardous

Materials Safety Administration (PHMSA, 2020), millions of miles of pipelines used in the plastics industry have resulted in more than 5,500 accidents causing nearly 600 injuries, more than 125 deaths, more than 800 fires, nearly 300 explosions, more than $4 billion in damages, and the evacuation of nearly 30,000 people from the site. Only about 5% of natural gas gathering lines in North America are currently subject to pipeline safety regulations. Not only are the majority of gathering lines unregulated, but even basic information about where they are located or whether they follow any safety procedures is not available. Such pipelines exist in major oil-producing and plastics-manufacturing industrial agglomerations around the world to transport raw materials for the manufacture of plastics.

Raw materials are transported through the process of processing and manufacturing into plastic products. During this process, crude oil is separated into its various components, known as fractions, which are divided into three main types: light, middle, and heavy fractions. The light fraction produces hydrocarbons: petrol, paraffin, and paraffin; the medium fraction produces diesel and tar; and the heavy fraction produces fuel oil. The light fractions are chemically broken down to produce two monomers - monoethylene glycol (MEG) and dimethyl terephthalate (DMT) or purified terephthalic acid (PTA) - which are chemically reacted to produce resins. The resin is cooled under high pressure and at high temperatures to become raw plastic pellets, which are the most basic raw material for the manufacture of plastic products (Williams and Rangel-Buitrago, 2022).

Plastics also contain additives that affect the properties of the plastic, including stabilizers, fillers, plasticizers, colouring, and a range of other additive categories that occur in production. At least 27 million tonnes of additives are added to plastics production each year, making plastics production a major contributor to environmental toxicity as most of the toxins from the production process are released into the air. Toxic chemicals emitted in large quantities during plastics production include trichloroethane, acetone, methylene chloride, methyl ethyl ketone, styrene, toluene, benzene, trichloroethane, oxides of sulphur, nitrous oxide, methanol, ethylene oxide, and volatile organic compounds (Smith and Vignieri, 2021) . Most of this causes irreversible damage to human health.

Although most companies have adopted waste minimization principles in their plastics manufacturing processes, emissions remain high due to the inherent difficulties of handling high volumes of pressurized gas. The production of PET has more toxic emissions (nickel, ethylbenzene, ethylene oxide, benzene) than the production of glass, and on average the production of one tonne of plastic resin will emit 1.89 megatonnes of CO_2 (Wei et al., 2020) . This is certainly becoming a non-negligible part of the total life cycle within the plastics regime.

Distribution is considered to be the “cleanest” part of the life cycle of plastics, but it can also have some negative impacts. Greenhouse gas emissions from plastic distribution (i.e. carbon dioxide from ships, aircraft, and cars) and also the loss and depletion of plastic products during transport amplify the environmental pollution of plastics, e.g. in 2018, 83 containers fell into the Tasman Sea from a Taiwanese container ship, and tens of thousands of plastic bottles washed up on the beaches of New South Wales, Australia (Ocean Conservancy, 2021).

There is no doubt that plastics have become an essential item in today’s world consumer economy. Over the past three decades, the number of plastic products has proliferated. From 1950 to 2017, the production and use of plastics “totalled 9 billion tonnes” (UNEP, 2023) and has grown exponentially over time (UNEP, 2021) . More than half of the plastics used in human history have been produced in the last 20 years, and half of all plastics to date can only be used once (Jambeck et al., 2015) . Plastic production is projected to double by 2050, with approximately 8 million tonnes of plastic waste entering the oceans from coastal countries each year (Geyer et al., 2017).

For plastic bottles alone, as mentioned earlier, the world consumes around 1 million plastic bottles every minute of every day, and by 2030, this number will grow by 30%. According to Euromonitor International (2019), more than 500 billion plastic bottles were sold in 2018, a figure that has increased by more than 48% since 2009.

Specifically, plastics are used by industry. 4% are used in electronics-related consumer goods, 4% in construction and building materials, 6% in transport and extended manufacturing, 12% in mass consumer products, 14% in textiles, 47% in packaging, and 13% in other industries (Smith and Vignieri, 2021). It is important to note that, in addition to industry differences, use and consumption vary by location. The North American Free Trade Area (NAFTA) accounts for 21% of global plastics consumption, followed closely by China at 20% and Western Europe at 18% (UNEP, 2022). Per capita plastics consumption is higher in North America and Europe, at 94 kg and 85 kg/person/year, respectively (Rudolph et al., 2017). In China, per capita consumption is lower (58 kg/capita/year), but national consumption is higher due to the large population (OECD, 2022).

It is essential to consider that the end of the "plastic life cycle" is not necessarily the end of the impact. After consumption and use, plastics follow different pathways, most of which are far from being environmentally friendly. Some plastic items can be recycled; however, this process requires many steps and optimal infrastructure to ensure correct collection, transportation, separation, processing, and re-manufacturing. The high cost of the previously mentioned steps, a low commercial value of recycled plastic together with a low price of virgin material means that plastic recycling is rarely profitable and requires considerable subsidies that many governments are unable or unwilling to pay. This step is out of hand for many countries because it can be too expensive from an economic viewpoint.

Global production of plastics has totalled 920 million metric tonnes since 1950, of which 60-90 million metric tonnes are poorly managed plastic waste (Raubenheimer and McIlgorm, 2017). Of all waste plastics, 91% have never been recycled, with 32% currently going directly into environmental ecosystems, 40% being disposed of in landfills, 14% being incinerated, and only 14% being recycled (PlasticsEurope, 2017). Of these last 14% (recycled plastics), 2% are optimally recycled and the remaining 12% are “downcycled”, generating materials of lower quality and functionality than the original. The original plastic becomes something worse, far from “good for the environment” (Ralston et al., 2023). More so, no matter which disposal method is used, waste plastics are harmful to the environment.

For many less developed countries, lack of technical capacity, poor governance, and inadequate financial resources are the main bottlenecks to improving waste management practices. Waste is a broad category that relies more on “self-management” by those who generate it, but without sufficient knowledge to guide or drive it, they usually dump it on land, in bodies of water, or burn it in uncontrolled open air. Mismanagement is seen mainly in wastes that have been collected and subsequently dumped in dumpsites that do not have adequate controls to prevent their interaction with the natural environment or humans (World Economic Forum, 2016). These situations occur mainly in less developed regions, but also in more developed regions.

Therefore, plastic is a very strong link between human life and production activities. Not only does this mean that plastics are present in many familiar or unfamiliar areas, but it also means that if we need to make a change to plastics, it will revolutionize the way we live and think about production as we know it. For now, it remains impossible to imagine a world without plastics, from oil companies in the Gulf to food giants that rely on single-use plastics to sell all kinds of products globally because cheap plastics benefit them. There is a fundamental and irreconcilable contradiction between the goals of global plastics governance and the economic interests of both (Tang, 2023). Changing things will also bring more than just a change in habits - it will determine the livelihoods of some, from the consumers who shop in front of the supermarket shelves to the poor labourers in third-world countries who recycle huge quantities of plastic waste from overseas to feed their families.

The breadth of the plastics industry and the sharp conflict between governance objectives and the economic benefits of the companies involved is one of the core factors contributing to the delay of the international plastics treaty. Some large and well-known multinational corporations, including Coca-Cola, PepsiCo, Nestle, Unilever, and Yizzee International, rely on expanding the use of plastics to reduce costs and seek economic benefits on the one hand, and on the other hand, through the global division of labour in the layout of production and the use of the global market to sell their products, with a wide range of businesses, are the “main responsible party” for plastic pollution (Rudolph et al., 2017). However, these multinational corporations generally take the position that they oppose treaty declarations restricting the production of plastics and support only green and clean policies on corporate plastic pollution. A Business Coalition for a Global Treaty has been formed by some consumer goods producers to lobby for this position (Ralston et al., 2023).

4. Availability of Substitutes

This section is a review of current available substitutes to traditional fossil-based plastic. In the last two decades, mankind has undergone extensive research to find a reliable alternative to plastics, the most representative of which is bioplastics. First of all, it should be clear that not all bioplastics are biodegradable and beneficial to the environment. Some bioplastics can cause or even aggravate environmental problems such as global warming, pollution, and drastic land use changes. Even though bioplastics are discussed in many domestic and international studies, they can be broadly divided into two categories: books or publications on bioplastics developed purely in the field of biochemistry technology, which provide systematic and specialized chemical analyses of existing types of bioplastics and research techniques and praise them as “reliable” petroleum-based alternatives to plastics. There are also reviews or articles in the social sciences that point out that there is no “ideal” bioplastic that can replace or substitute for traditional petroleum-based plastics in human society at this stage. In other words, there are very few reviews that comprehensively address the positive and negative environmental impacts of bioplastics. Apart from the debate about the feasibility of bioplastics to substitute fossil-based plastics in the academic community, the application of bioplastics in industry and its production is limited, with only 0.9% (UNEP, 2023). The availability of substitutes determines the costs of the transition of traditional plastic markets. These costs are significant factors in the interest analysis of actors about whether to support or oppose the plastic regime (Aanesen et al., 2024; DeSombre, 2000). If there is an ideal substitute for fossil-based plastics, states and the plastic industry which are originally against the regime may turn to advocate the control of environmentally unfriendly plastic instead. Their support may be even stronger when they hold the intellectual property rights to the production of substitutes and the capability to switch production.

Therefore, this section will explore the following issues: 1) the types of bioplastics currently in human society (both those already in commercial use and those still under development); 2) the comprehensive environmental impacts of bioplastics; and 3) how the controversial impacts of bioplastics on the environment can be better addressed to rationally and comprehensively analyse the beneficial factors and harmful effects of bioplastics on the environment.

4.1 Types of available bioplastics

Bioplastics are a class of polymer materials that refer to 1) biodegradable plastics, such as polycaprolactone (PCL) and polybutylene succinate (PBS); and 2) biodegradable or non-biodegradable plastics produced from biomaterials or renewable raw materials. Because it is functionally similar to traditional synthetic plastics, human beings hope that bioplastics can become a material that is harmless to the natural environment, and in the face of serious environmental problems caused by waste plastic pollution, bioplastics may become a substitute for plastics.

Bioplastics are produced from biomaterials or renewable raw materials, such as starch, cellulose, vegetable oils and plant fats (Babu et al., 2013; Tokiwa et al., 2009). Like other polymeric materials, the natural degradability of bioplastics is affected by their composition and environmental factors, and the degradation time can be as short as a few days or as long as several years.

According to the degradation mechanism, biodegradable plastics are divided into two main categories, oxo-biodegradable plastics and water-based biodegradable plastics (Iwata, 2015). Firstly, oxo-biodegradable plastics are made from petroleum-based polymers mixed with a degradation-promoting metal salt (manganese or iron) that enhances the abiotic degradation process of oxo-biodegradable plastics in the presence of oxygen (da Luz et al., 2013; Siracusa et al., 2008; Thomas et al., 2012). Degradation of oxo-biodegradable plastics usually takes months or even years.
Second, water-based biodegradable plastics are hydrolysed more rapidly than oxo-biodegradable plastics, which can be converted into synthetic fertilisers. Specifically, this includes bioplastics and polylactic acid (PLA) produced from plant feedstocks. The following section summarizes the various types of bioplastics that have been developed or are under development.

Thermoplastic starch plastics: Starch, as a biodegradable biopolymer obtained from naturally renewable plant resources, is renewable, inexpensive and fungible (Huang et al., 2006; Otaigbe et al., 1999). Starch can be configured into suitable thermoplastic materials and can be readily processed into forms usable for productive life. Starch-based bioplastics can be used in the production and packaging of food utensils such as cups, bottles, dishes, cutlery and straws.

(1) Polyhydroxyalkanoate (PHA): PHA is a class of bio-based plastics that are synthesized from renewable plant sources such as certain bacteria and plants. It is biocompatible, biodegradable and non-toxic. In particular, PHA can be produced not only from methane released from wastewater treatment facilities, landfills, food processing plants and other sources but also from grass and crop residues (Curry and Pillay, 2012; Semprini et al., 1991; Vigneswari et al., 2014). The production of PHA is commercialised, which makes its application relatively more realistic and feasible. At this stage, PHA can be used commercially in some applications such as bioplastic packaging, and shampoo bottles. PHA bioplastics can be naturally digested by marine microorganisms after decomposing into methane and entering the ocean. Then there is polyhydroxybutyrate (PHB), one of the most widely used PHAs, as PHBs are biodegradable and are rated as an attractive and environmentally friendly alternative to fossil-based thermoplastics (Smith, 2005; Woodford, 2023). It is commonly used in lifestyle applications such as disposable tableware and waste packaging materials or in biomedical engineering applications such as surgical sutures (Muniyandi et al., 2020) . However, other research points out that PHAs are still in the nascent stage without large-scale usage due to their relatively high production costs and the weakness in thermal and mechanics properties of PHB (Singh et al., 2015).

(2) Polylactic Acid (PLA): PLA is made by polymerizing lactic acid from renewable resources such as corn starch, tapioca root and sugar cane (Sin et al., 2012). Because PLA is too fragile, this results in them not being able to be used in other packaging manufacturing processes, but only in disposable tableware for the food industry. It must be recognized, however, that PLA is one of the most readily biodegradable thermoplastics, so additives are often used to make PLA more durable (Nagarajan et al., 2016). Several commercial grades of PLA are available today.

(3) Cyanobacterial Photosynthesis: Cyanobacteria naturally produce plastics using their own synthesized glucose. It has also been shown that it is feasible to produce polymers using genetically engineered sugar-feeding cyanobacteria, a method that

could replace fossil fuel-based plastic production processes (Juneja et al., 2013; Venkata Mohan et al., 2020; Yim et al., 2011). However, a possible problem with this biotechnology is that plastic production is too dependent on feeding plastic-producing bacteria with large amounts of sugar obtained from natural crops. Since natural crops are the food for human and animal survival, we may upset the competitive balance of limited agricultural resources (Strong et al., 2016).

(4) Butylene Glycol (BDO) Bioplastics: BDO is an industrial chemical used as a solvent and basic ingredient in bioplastics (Ciardelli et al., 2019). Bioplastics made from BDO are fully biodegradable. A good example is PBS, a semi-crystalline thermoplastic whose key monomers can be produced not only from fossil-extracted feedstocks but also can be synthesized via a biocatalytic pathway from renewable carbohydrate feedstocks such as glucose or sucrose. PBS is more cost-effective and can be used in a variety of applications such as disposable food packaging, mulch, flowerpots, hygiene products, fishing nets and fishing lines.

(5) Seaweed polysaccharide bioplastics: Seaweed can grow in a wide range of natural environments, which makes it less difficult to cultivate in natural environments. Bioplastics produced from seaweed minimise the impact on the food chain, in addition, seaweed bioplastics do not rely on chemicals. This is why seaweed is an excellent candidate as a material for the production of bioplastics (Rajendran et al., 2012). The most commonly used seaweed species in industrial production are diverse and undergo a series of chemical reactions to form gels, the properties of which encompass a wide range of industrial applications for almost all thermo-mechanical bioplastics (Venugopal, 2016).

(6) Bioplastics based on fungal mycelium: New York-based company Evocative utilizes mycelium - the fungal extension that produces mushrooms - to create plastic-like materials for biodegradable packaging (Kim and Ruedy, 2019; Stamets, 2005). The mechanical properties of these mycelia are sufficiently robust to allow the biomaterial to be used in a range of industrial applications. For example, IKEA is

using mushroom-based packaging to avoid other materials that would cause environmental pollution and waste of resources (Dahmen, 2017).

(7) Bioplastics from crab shells or tree litter: Wu (2014) has created a new type of bioplastic derived from crab shells and tree fibres to replace the flexible plastic packaging used in food wrap. Researchers compared the new bioplastic to PET - the most common petroleum-based plastic used for transparent packaging - and found that the new packaging was safer and more effective in holding liquids and food (Niaounakis, 2019; Srinivasa and Tharanathan, 2007). The new bioplastic material is 73% less permeable to oxygen than fossil-fuel-based PET, which keeps food fresher for longer (Satam et al., 2018).

4.2 Integrated environmental impacts of bioplastics

Whether bioplastics are friendly for the environment, or they have a less harmful impact compared to the negative environmental impact of traditional petroleum-based plastics, is a question worth pondering and a starting point for research, development and application of bioplastics.

The types of bioplastics currently available in human society have been listed above, both those already in commercial use and those still under development. However, the environmental impact of these emerging bioplastics remains controversial. Although these bioplastics are often touted as the best alternative to traditional plastics, they have some drawbacks (Licciardello and Piergiovanni, 2020).

We use biodegradable bioplastics as an example of a comprehensive impact analysis of bioplastics: Firstly, biodegradable bioplastics will be broken down into natural materials through microbial mechanisms and then harmlessly incorporated into the soil (Alsherhei, 2017; Kale et al., 2007). This decomposition process requires the help of water and/or oxygen. For example, the corn starch molecules in starch bioplastics slowly absorb water and expand when buried in the ground. The starch bioplastic then breaks down into small fragments, which can then be easily digested by bacteria (Cabezas et al., 2012; Kale et al., 2007; Laville and Taylor, 2017; Ritchie, 2018). However, some low-degradable or non-biodegradable bioplastics can only be broken down if treated at high temperatures or in specialized municipal composters (Hermann et al., 2011; Jouhara et al., 2017; Lancelot and Moriyama, 2010). Other bioplastics can only be degraded in specific active landfills under certain well-defined experimental conditions (Mohanty et al., 2000). However, during the decomposition, methane gas will be produced, which is a greenhouse gas that is several times more potent than carbon dioxide (Knoblauch et al., 2018). Methane contributes significantly to the problem of global warming (Lashof and Ahuja, 1990).

Secondly, a study comparing seven traditional plastics, four bioplastics and one plastic made from fossil fuels and renewable resources showed that the production of bioplastics produced more pollutants (Walker and Rothman, 2020). This is due to the chemical processing that is carried out to meet and enhance the industrial and domestic applicability of bioplastics, as well as fertilizers and pesticides in crops. Studies have shown that bioplastics have a greater impact on ozone depletion than traditional fossil-based plastics (Cho, 2017).

Further, the production of bioplastics has unintended socioeconomic drawbacks. Plant-produced bioplastics, such as those utilizing plants such as corn, require the reuse of land to produce plastics, occupying valuable and limited farmland for plastics production instead of meeting the demand for food (Gerngross and Slater, 2000). Statistics show that nearly a quarter of the agricultural land used to produce grains is used to produce plastics and biofuels. This could lead to a significant increase in the price of food, hurting economically disadvantaged countries and vulnerable groups (Popp et al., 2014).

Finally, bioplastics may also have adverse effects on the human body. One study found that a hybrid bioplastic (bio-based PET) is a potential carcinogen that is not only harmful to humans but also has harmful toxic effects on the Earth's ecosystems (Sabbah and Porta, 2017; Zhang et al., 2020).

In summary, the development and application of bioplastics at this stage certainly have environmental advantages. For example, the production of PLA can save two-thirds of the energy needed to manufacture traditional plastics, and there is no net increase in carbon dioxide gas during the biodegradation of PLA bioplastics. In addition, greenhouse gases emitted when PLA is degraded in landfill sites have been reduced by 70%. However, despite these one-sided arguments, generally speaking, bioplastics can lead to negative impacts on the earth's environment, socioeconomics and human health. Bioplastics have a long way to go to become the "ideal" alternative to fossil-based plastics. Therefore, although bioplastics have great potential to replace fossil-based plastic in an environmentally friendly way, by now bioplastics are still lacking the comprehensive environmental and socioeconomic properties to be "the substitute".

4.3 How the controversial environmental impacts of bioplastics can be better addressed?

A holistic comparison of bioplastics and conventional plastics is required for better development and application of bioplastics, to make bioplastics a better alternative to conventional plastics. The key to this comparison is to accurately assess the environmental impact of bioplastics from their initial production, through industrial production and daily use, to their final disposal. This is done using Life Cycle Assessment (LCA), a "cradle-to-grave" analytical approach (Gironi and Piemonte, 2011; Iles and Martin, 2013; Jawahir et al., 2006). This is the most important tool for assessing the environmental impact of bioplastics and/or conventional plastics, and the process helps to determine the overall environmental impact of bioplastics at all stages of their life cycle.

Specifically, this means assessing the entire life cycle of an industrial product such as bioplastics at all stages: starting with the extraction of raw materials and continuing through material processing, manufacturing, transportation, distribution and use. Impact studies for life cycle assessment include assessments of global warming, human health, abiotic depletion, eutrophication and acidification (Chen et al., 2010; Huijbregts et al., 2003). In addition, emissions associated with land use change (LUC) must be considered, as well as the costs and economics of the final disposal of bioplastics.

An accurate life cycle assessment will be an important reference for decision-makers (Plevin et al., 2014) . One study, for example, using LCA methods and the methodology provided by the Intergovernmental Panel on Climate Change (IPCC), demonstrated a significant reduction in greenhouse gas emissions when replacing 20 per cent of PET with PLA in the manufacture of bottles (Harding et al., 2007; Martín-Gamboa et al., 2020; Piemonte, 2011; Tagliaferri et al., 2016). Indeed, there are many more LCA studies on the market for PLA plastics (Ruggero et al., 2019). In addition, LCAs for other bioplastics, not just PLA, could provide valuable data such as this to support decision-makers in selecting appropriate bioplastic materials.

Furthermore, life cycle assessment is an important tool for determining the best methods for bioplastic waste management and disposal. Because plastic itself is not a pollutant, the essence of plastic pollution is that poor management and disposal of waste plastics leads to leakage into the natural environment, resulting in environmental pollution. Therefore, if we want to become a qualified plastic substitute, the management methods and disposal measures of waste bioplastics should be paid extra attention. For example, LCA analysis has shown that incineration or landfill of bioplastic products is not a useful alternative (Kale et al., 2007) . Adherence to the "LUC" emission principle has been recognized as a reasonable solution to the problem of bioplastic waste management (Philp et al., 2013).

It was concluded that future research and applications on bioplastics should focus on individual life cycle assessments for the growing number of bioplastics. It has been argued that bioplastics should be customized and used only when needed. There is no doubt that we must weigh these environmentally relevant disadvantages of bioplastics against the environmental damage caused by conventional plastics, and although bioplastics cause relatively little harm compared to conventional plastics, the shortcomings of bioplastics currently in use remain unresolved. We look forward to the development or improvement of new and "ideal" alternatives to plastics as researchers in academia and industry continue their efforts.

5. Differentiated positions of states

Interests and positions of different states are crucial in negotiating the global plastic regime. The global governance of plastic pollution is a multistakeholder issue, involving full participation and contributions of states, firms from the up-, mid-, and downstream of the plastic production chain, as well as terminal consumers. However, in the actual international negotiation process to reach and formulate an international instrument on the plastic pollution problems, states are the dominant actors. Although different IEAs differ, in terms of the plastic regime, the whole negotiating, decision-making, and lawmaking process have taken place in the framework of the United Nations (UN), particularly the UNEP. Only sovereign states are valid to have memberships in UN organisations. According to the Vienna Convention on the Law of Treaties, only states and other subjects in international law (intergovernmental organisations and certain specific national liberation organisations) have the capacity and competence to legally conclude treaties. In the end, adopting the plastic instrument requires the consent of states.

Although whether the international system is anarchic or not is not completely agreed upon based on different perspectives and theories, in reality, a supernational authority which has compulsory power to regulate the behaviours of states is absent. Therefore, acceptance and fulfilment of an IEA is voluntary self-enforcement by states (Barrett, 2005). The basic consensual principles of international law, including free consent, of good faith, and *pacta sunt servanda*, are not regulatory but hold only reputational mechanisms to discourage noncompliance (Guzman, 2002) . Therefore, it is even impossible to force a state to join the global plastic regime against its consent. The process of international lawmaking to create such a regime must be negotiatory as it has to position itself in the Zone of Possible Agreement among various states. It means the regime must undergo the state's domestic cost-benefit analytical decision-making process and the game among the state's internal interest groups, then to be recognised as aligned with the national interests. Hence, it can receive the consent of such a state, and this process has to succeed in other states repeatedly. Plastic pollution and many other international environmental problems have a transnational nature, and to address it is a public good requiring international cooperation (Chasek et al., 2018). To create a successful global plastic regime, it has to be aligned with different states' interests, especially those being significant contributors to this problem. If it fails, states that are not part of this regime are boundless to the regime's regulations, then the free-rider problem could be too severe to even negate the effect of the regime. If the major producers and consumers of the plastic industry are not included in the regime, but only some insignificant stakeholders who bear the costs of plastic pollution are its parties, how can the regime be successful? Therefore, the regime to address plastic pollution must balance the interests of different states, including those that are mainly the victims of this problem and those interests that are adversely connected to the plastic industry.

Plastic pollution is both an environmental and economic issue. The environmental and economic factors associated with plastic pollution are not uniform across states, so the interests of states are differentiated. The production and consumption of plastic products are valued economic activities, but plastic pollution is an uncounted environmental externality. The economic benefits and environmental costs of plastics are globally mismatched. The highest value-added part of the plastic production chain, namely the upstream and midstream, is concentrated mainly in the industrialised high-income countries and some middle-income countries, but the most environmentally unfriendly and health-threatening downstream part is born by underdeveloped developing countries. Low-income and middle-income countries are taking 8 times higher costs than high-income countries (WWF, 2023).

Besides the economic disparities, plastic pollution is remarkably an oceanic problem. Among all the produced plastics, 14% are incinerated and 76% are discarded in landfills or the ocean (Geyer et al., 2017). About 0.77 billion tonnes of plastic waste is transported into rivers, coasts and oceans every year, accounting for 2% of total plastic waste generated annually, and 88% of ocean plastic waste floats close to the shoreline (OECD, 2022). Plastic wastes discarded on islands are more likely to be transported into the ocean due to the effect of terrestrial runoff, and the ocean currents will transport the plastic throughout the oceans (Meijer et al., 2021; Onink et al., 2021). The absolute number may be unappalling apparently, but the high seas are beyond any state's jurisdiction.

Undergoing several attempts, UNEP/EA.5/Res.14 adopted in 2022 finally marked an agreement among states to formulate an international instrument to address plastic pollution. The title of the resolution ambitiously calls for the end of plastic pollution, but in the text, it demonstrates a more flexible stance which notes to take into account national circumstances and capabilities.

There certainly is a convergence in states' national interests because plastic pollution harms the Earth's environment and human health at the expense of every individual living on our planet. Therefore at least, the world is finally negotiating a regime to tackle it. However, addressing the problem is costly and some states have to make greater efforts to mitigate it. The differentiation in states' positions postpones the formulation of the regime as every state tries to maximise its benefits in the bargaining process, and the compromission to find the multilaterally agreed regime is time-consuming. Before the resolution (5/14), there were several attempts to initiate the international lawmaking process for the plastic regime in the UN framework, but unfortunately, all of them failed (Stöfen-O'brien, 2022). A regime can be successful only when it meets the consent of all important stakeholders. When national interests are diverse, reaching a consensus can be difficult.

6. Regime-making process

The creation of an MEA takes time, as it will go through complex bilevel lawmaking processes. Chasek et al. (2018) summarise the regime-creating process into five interrelated steps, agenda-setting, fact-finding, bargaining, implementing, and reviewing. The previous section has discussed how international society has evolved its awareness of the plastic pollution problem over decades. The academic community, media, and civil society have contributed to raising awareness from plain illustrations about the issue to a well-recognised global marine environment crisis, then eventually up to the political level. National policies have been made to regulate the use of single-use plastic products. The Danish government was the first state to develop taxation over single-use plastic bags to the manufacturer by weight in 1994, and Bangladesh was the first country to ban the production and use of plastic bags in 2002 (Liao et al., 2018). Since the 1970s, certain IEAs have touched upon the issue of plastic pollution, including the International Convention for the Prevention of Pollution from Ships, 1973, its Protocols and amendments in 1978 and 1997, the Basel-Rotterdam-Stockholm Conventions framework, the 1972 London Convention and the Protocol to it, and other efforts by international organisations and regional instruments.

However, these regimes have not targeted plastic pollution itself or lack global involvement. To conclude a global treaty on this problem, the UN framework is necessary. The attention to the plastic pollution problem has peaked twice in the UN system. The first round of concern occurred from the 1990s to the early 2000s, but the problem didn't gain its subjectivity that plastic debris was just a normal sort of pollutant under the broad categorisation of marine debris and wastes. The importance of plastic pollution surged at the Rio+20 Summit, in 2012, when states launched the development of Sustainable Development Goals. At the summit, the urgency of marine plastic pollution was raised in the global context. Followed by the first session of the UNEA in 2014, when the serious environmental, economic and public health harms induced by marine plastic and microplastics were noted with concerns, and the precautionary approach to addressing the pollution was stressed globally (United Nations Environmental Programme, 2014) . Thereafter, UNEA resolutions (2/14), (3/7), (4/6), (4/7), and (4/9) continuously highlighted the serious impact of plastic pollution and called for voluntary actions, but no legally binding measures were announced. From the solution-oriented perspective, the international legislation of the plastic regime has stalled since its agenda was set on the UN level in 2014, and no more substantial progress has been made yet until 2022. Eventually, at the resumed session of UNEA-5 interrupted by the unexpected COVID-19 pandemic, a milestone toward the regime was set as the resolution underlined and initiated the international negotiation process to establish an instrument to end plastic pollution (United Nations Environmental Assembly (5th sess. : 2021 : Nairobi), 2022). Resolution (5/14) finally marked the end of the agenda-setting step and initiated the bargaining process. Even if we only count the procedures that occur in the UNEP system, the agenda-setting step lasts for eight years. These eight years mean from 3600 to 4000 MMT of plastics are produced (Ritchie et al., 2023).

The bargaining process happens in the framework of the International Negotiating Committee (INC), which is expected to hold five sessions from 2022 to December 2024, with the mandate to formulate a draft of an international instrument on plastic pollution. The negotiations are taking place intensively now to reach a globally agreed and responsible regime. What exactly the instrument will be formed, and whether the negotiations would be extended are determined by how the bargaining goes, which is yet too early to draw an estimation. However, in the most ideal scenario that the instrument will be formulated at the end of 2024, there is still an adoption process before the regime will be commenced to implement, and implementation still takes time to turn into effect. The adoption process will last for years as most international treaties stipulate that the treaty will enter into effect when a stipulated number of parties have adopted the treaty. The annual signature rates have been about 15 for MEA amendments and 5 for protocols, and the signature rates dropped drastically from about 20 to 5 in the 21st century (Mitchell et al., 2020). On average, it will take over four years for an MEA to enter into force (Blasiak and Jouffray, 2024) . Therefore, the time of entry into force of this plastic instrument could be in the 2030s.

After a state signs the MEA, it must go through the ratification process in the national legislation to connect the international agreement to the domestically approved law. Then the state can be truly legally bound by the regime. The ratification process can be challenging due to different domestic institutional contexts. In some states, the ratification process takes years because of the complicated and burdensome legislative institutions, and in some cases, it even fails. For instance, the United States signed the Kyoto Protocol during the Clinton Administration, but the ratification was declined during the G. W. Bush Administration. This paradox sometimes occurs because, in certain states, the office holding the executive power cannot fully represent the national interests and the equilibrium of domestic powers. The ruling party may only control the executive power, but in the legislative branch, it may be checked by its opponents. The ratification can be a term in the domestic political game, and if the ruling party trade it off for legislative support in other affairs or simply the opponent rejects to cooperate, the setback may put the ratification beyond reach. The political timings and environmental concerns sometimes mismatch (Chasek et al., 2018) . When the next election takes place, the ruling party may change, as well as the ruling ideology and the state’s consent. Traditionally, developing countries are seen as politically unstable, but in the recent decade, if the scope is limited to the ruling ideology, the political polarisation has spread to Western developed countries. The world witnessed the unpredictability of the Trump Administration in the US. In Europe, right-wing populist movements surge. Brothers of Italy took power in 2022, and the popularity of Marine Le Pen and AfD reached an all-time high in France and Germany. If conservatives and environmental sceptics keep triumphing in the US and influential European states, not only the time when the plastic regime will enter into force but also whether the regime will be adopted can be questionable.

International treaties work based on the consent of states, but consent is not static and permanent. If a state's ruling ideology shifts due to domestic power transfer or the cost-benefit analytical context experiences major transformation, the consent given previously may be invalid. In certain cases, states can withdraw from the bounds of the treaty legitimately (Zhang and Pan, 2017). To maintain the consent, the negotiation process will not be once and for all but be interactional usually through the autonomous institutional arrangements stipulated in the text, namely Conference of Parties (COPs) or Meeting of Parties (MOPs) (Brunnée, 2002; Churchill and Ulfstein, 2000). COPs and MOPs will keep on the negotiation process and adjust the regime to fit the ever-evolving reality and, more importantly, to ensure consent and collective action among parties. The institutional arrangements are also responsible for reviewing the implementation of parties.

Implementation must be carried on putting the measures in the regime's text into real effect. The world's expectations of the plastic regime are not just right sayings, promises and cliché, but effective actions stopping plastic pollution from harming the environment and human health. The degree of the regime's implementation to alleviate the problem is determined by the ongoing negotiations about the specificity of the instrument. From the environmentalist perspective, if it is fortunate that the final instrument is specific enough to solve the plastic pollution problem globally, the world still counts on the degree of implementation by different states. The difference in the state's capacity is an issue. Common practices in the MEAs are accepting the Common But Differentiated Responsibilities principle, which grants developing countries grace periods in years to implement the control measures. Therefore, the actual alleviation could wait until the grace periods end. However, if the negotiation process fails to agree upon a specific protocol-like instrument but something close to a framework agreement, the vague text in the regime doesn't stipulate states to carry on effective measures. Then, the world cannot be satisfied that this treaty is the one that has been waiting for. The world may need another treaty which is effective enough when everything has evolved to favour it in the future, but this future may be too far away to be predictable.

7. Summary

Since the invention of plastic in 1907, the world has waited for more than a century to sit down to negotiate a global regime to regulate the pollution it induced. Even if we trace the starting point back to the 1970s when the awareness of mass plastic production's environmental and public health externalities was raised, the global response was still delayed for half a century. The negotiations for the global plastic regime are still far, far from the solution. Procedures following to alleviate the pollution de facto that meet the public's expectations could take more time beyond our prediction. In the most ideal scenario proposed by the HAC, they aim to end plastic pollution by 2040, but no one can ensure that the system will change this way. The costs of delaying are appalling. Given the current sheer volume of plastic production, for every one-year delay in making changes, 227 MMT more plastic will be discarded in the ocean, accumulating with the legacy plastic which may not be removed (UNEP, 2023).

The reasons for the delay in this regime are multi-dimensional. Fundamentally, plastic pollution has not gained enough attention for decades, yet until the notion of microplastics in 2004. The newly discovered serious ecological and public health impacts of plastics finally warned global society that plastic pollution is not a simple branching of normal waste. Another critical impediment is the omnipresence of plastic products and the strong power of the petroleum and the plastic industry. Regulating plastic products is way too difficult compared to the control measures of fluorocarbon in the remarkable Ozone Regime. Industrial sectors are reluctant to change and are exerting influential lobbying power in the agenda-setting and the current negotiating process. The absence of feasible, pragmatic, inexpensive, biodegradable and green substitutes for fossil-based plastic is a major setback for the regime (Aanesen et al., 2024; DeSombre, 2000). Available feasible substitutes can significantly alleviate the costs of controlling pollutants and shift the positions of major enterprises and states. The differences in national interests hinder the converging of states' positions in and before the negotiating process. It takes more efforts to align the national interests between the victims of plastic pollution and states economically relying on the plastic industry. The alignment will not only influence the pace of the regime-making process but also determine the effectiveness of the regime. Then finally, the MEA-creating process is complex and time-consuming, because the milestone the world achieved, the initiation of plastic regime negotiations, may not be the most difficult part. The subsequent ratification process can be even more challenging and burdensome, without mentioning the actual implementation and reviewing. The road to building the plastic regime will never be easy in every regard.

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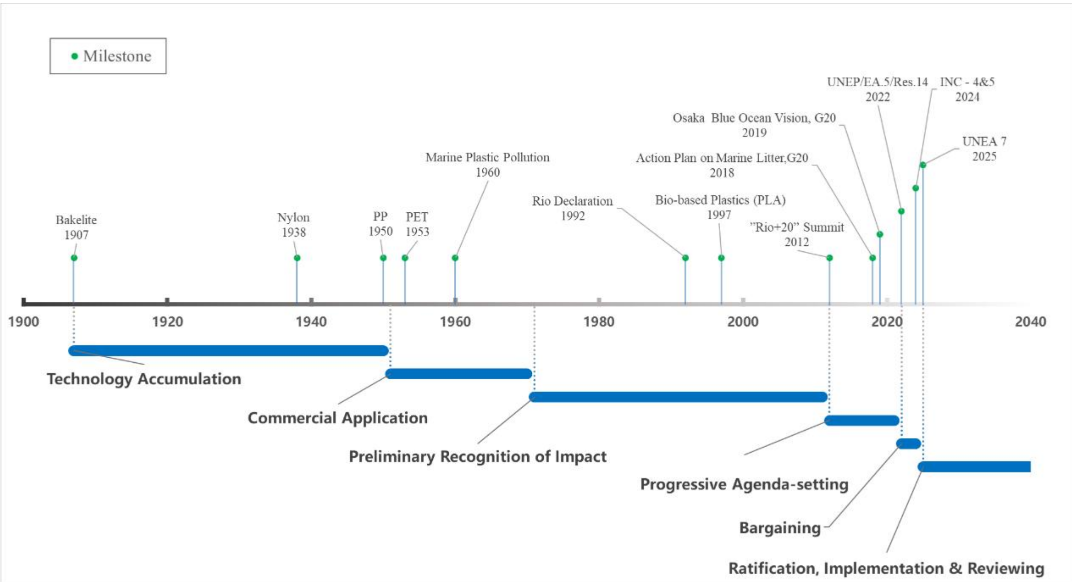
Appendix 1:



Plastic Timeline (1900-2040), including a series of stages and milestones related to technology accumulation, development of the plastic industry, Preliminary impact, and international regime actions.

Current status, problems and suggestions for resource utilization of waste slag from major infrastructure projects

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Abstract: During the construction process of major infrastructure projects, a large amount of waste soil and slag (stone) will inevitably be produced. The resource utilization of waste soil and slag (stone) remains a low level, and the comprehensive benefits of waste slag have not been fully utilized. The main reasons include the late start of reuse, unclear inventory and composition, information asymmetry, difficulty in communication between supply and demand, lack of supporting systems, imperfect reuse procedures, extensive utilization methods, and potential environmental risks. At present, there is a large demand for gravel resources in rural revitalization. The resource utilization of waste slag is legally guaranteed, and the utilization technology is relatively mature and has significant benefits. There have been successful cases of resource utilization of waste slag, which proves that the resource utilization of waste slag from major infrastructure projects is feasible. To this end, countermeasures and suggestions for resource utilization of waste slag are put forward, which can effectively alleviate the demand for gravel resources in rural revitalization and effectively promote the realization of rural revitalization.

Key words: Major infrastructure projects, waste slag, resource utilization, rural revitalization

ZHU Zhenya, ZHANG Ji, YAN Fengling, LI Zhijun, LEI Xiaoqin. Current status, problems and suggestions for resource utilization of waste slag from major infrastructure projects. BioGreen - Biodiversity Conservation and Green Development. Vol. 1, May 2024. Total Issues 61. ISSN2749-9065

Review on the lack of "biodiversity conservation" in the green building policies

By SHEN Yihang

Abstract: At present, there is a common problem in the relevant policies, regulations and standards of "green buildings" in various places: "biodiversity conservation" is not taken into consideration. In other words, the synergy between addressing climate change and protecting biodiversity is separated. Based on this, this article explores "what kind of building can be called a 'green building'" through specific case analysis. It believes that the construction industry, as an industry that has a profound impact on the ecosystem and natural environment, should take into account the importance of biodiversity conservation while responding to climate change.

Key words: Green buildings, swallow brick, climate change, biodiversity

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In many folk buildings in southern China, the top of brick houses often has hollow structures, becoming an artificial habitat similar to "swallow bricks". During the survey, the author observed that birds enter and exit the holes in these houses frequently.

Photo by: Linda © CBCGDF Media · OceanWetlands Working Group

Swallow brick. Source: Manthorpe Building Products' factory

A swift peeks out from the nesting brick. Source: Ben Andrew/RSPB

Congratulatory message for STONE

By HU Deping

Abstract: This article is a congratulatory message for the 40th anniversary of the establishment of STONE. It starts from three aspects: “The Birth of STONE”, “The fluctuation of STONE”, and “New situation with Cathay”. “Free combination, self-financing, independent operation, and responsibility for profits and losses” is the commonality of all private enterprises, and it is also the operation situation of private enterprises.

Key words: STONE, private enterprise, operation and management

HU Deping. Congratulatory message for STONE. BioGreen - Biodiversity Conservation and Green Development. Vol. 1, May 2024. Total Issues 61. ISSN2749-9065

Exploring the sand industry to accelerate the formation of "new quality productive forces" for efficient utilization of water resources

By WANG Xiaoqiong, WANG Jing

Abstract: Water resources and food security are inextricably linked. Water resources are a key element of agricultural production and a rigid constraint affecting food security. How to develop and utilize water resources rationally and improve utilization efficiency has become a key part of the national food security strategy. Understanding and practicing the sand industry can help people dialectically understand the natural conditions in arid and semi-arid areas, and correctly understand the relationship between desertification prevention and rational development and utilization of water resources. This further help to establish the strategic thinking of integrating prevention and control into development and utilization, promoting governance through development, and ensuring development through governance. This article explores the sand industry and proposes a feasible plan to explore the formation of "new quality productive forces" for efficient utilization of water resources by supporting and promoting new thinking, new methods, new models and new templates about the sand industry.

Key words: Water resources, sand industry, the sixth industrial revolution, new quality productive forces

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Plant elves in spring

By AN Qinqin, HUO Daishan, QIN Xiufang, YANG Xiaohong

Abstract: New colors are the protagonists of spring, and all things are full of vitality. The flowers interpret the friendship with the Earth. Bring your eyes to discover the plant elves to appreciate the plant elves in spring. This article introduces five plants in spring, including the Oriental paperbush (*Edgeworthia chrysantha*), Persian speedwell (*Veronica persica poir.*), Purple-leafed plum (*Prunus × blireana cv. Meiren*), Chinese redbud (*Cercis chinensis*) and Celery-leaved buttercup (*Ranunculus sceleratus L.*), for the readers' enjoyment.

Key words: Spring, plants, Oriental paperbush, Persian speedwell, Purple-leafed plum, Chinese redbud, Celery-leaved buttercup

AN Qinqin, HUO Daishan, QIN Xiufang, YANG Xiaohong. Plant elves in spring. BioGreen - Biodiversity Conservation and Green Development. Vol. 1, May 2024. Total Issues 61. ISSN2749-9065

Oriental paperbush

Persian speedwell

Purple-leafed plum

Chinese redbud

Celery-leaved buttercup

The Future of Humanity - From Global Civilization to Great Civilization: A profound interpretation of "sustainable survival and development"

By WANG Jing, ZHOU Jinfeng

Abstract: The book *The Future of Humanity - From Global Civilization to Great Civilization* explores the multiple crises faced by mankind, including geopolitical conflicts, climate change, resource depletion, etc., as well as long-term deep crises in technology, evolution and civilization. These crises are rooted in the industrial civilization model and pose severe challenges to human survival and development. The author of this book proposes scientific and rigorous solutions to the severe challenges faced by mankind in the future, emphasizing the importance of soft technology based on "human psychology, thinking, cognition and behavior" in the realization of great civilization.

Key words: Human civilization, industrial civilization, ecological crisis, soft technology

WANG Jing, ZHOU Jinfeng. *The Future of Humanity - From Global Civilization to Great Civilization*: A profound interpretation of "sustainable survival and development". BioGreen - Biodiversity Conservation and Green Development. Vol. 1, May 2024. Total Issues 61. ISSN2749-9065

Photo by Tammy

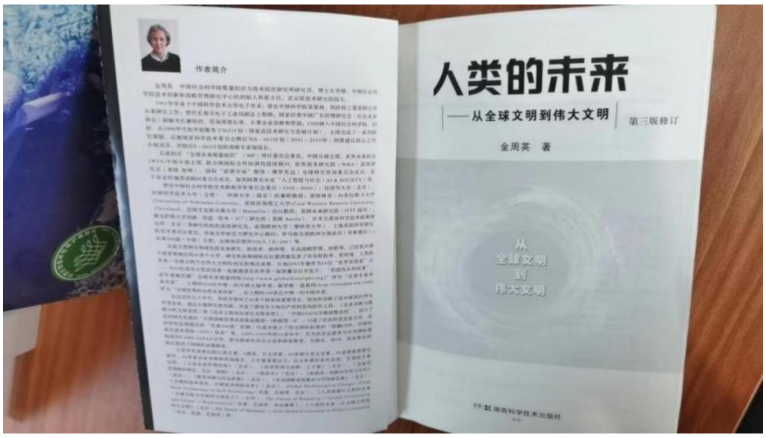

Photo by Tammy

Dr. Zhou Jinfeng, Vice Chairman and Secretary-General of China Biodiversity Conservation and Green Development Foundation and Executive Committee Member of The Club of Rome, innovatively put forward the theory of "Human-based Solutions", "Three Axioms of Pollution Treatment" and "Four Principles of Ecological Restoration", and Biodiversity Conservation in Our Neighborhood (BCON), "Carbon Equality" theories, etc.

Respect the power of natural succession and protect wetlands

By ZHOU Jinfeng

Abstract: Based on the on-site research at the Ecological Environment Bureau of Pidu District, Chengdu City on Yunqiao Wetland's application for "Biodiversity Conservation and Green Development Demonstration Base", this article discusses the important goal of protecting the water source of Yunqiao Wetland and the scale of human intervention after having deviation from the conservation goal, and then the issue of "invasive alien species", such as water hyacinth, channeled apple snail, Canada goldenrod, smooth cordgrass, etc. It emphasizes that the management of invasive alien species should also depend on whether they pose a threat to our main conservation goals. If they do not pose a threat, the greatness of nature far exceeds that of humans.

Key words: Wetlands, invasive alien species, human intervention, nature

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