



Dream, Believe, Achieve



ENVIRONMENT CONCLAVE — & — HIMACHAL CLIMATE ACTION AWARD

— 2026 —



ABSTRACT BOOK



2026

*"Advancing Environmental Sustainability
Through Research, Innovation & Action"*

ORGANIZED BY

LLR EDUCATIONAL TRUST, SOLAN
LR GROUP OF INSTITUTES, SOLAN



MESSAGE FROM THE MANAGING DIRECTOR

ENVIRONMENT CONCLAVE 2026

The Abstract Book of Environment Conclave: Himachal Pradesh Climate Action Awards 2026 compiles research papers, case studies, and innovative ideas from researchers, academicians, students, and practitioners dedicated to environmental sustainability and climate action.

The abstracts in this volume address pressing environmental challenges through scientific research and practical solutions. They highlight the importance of collaboration, knowledge sharing, and evidence-based approaches to build a climate-resilient future.

Guided by the theme "Lifestyle for Environment - LiFE", these contributions emphasize sustainable living, responsible consumption, and community-led initiatives for environmental protection.

I express my sincere appreciation to all the authors for their valuable research, to the reviewers for their diligent evaluation, and to the organizing committee and partners for their support in bringing out this publication.

I trust this Abstract Book will serve as a useful reference and inspire continued efforts toward conservation, innovation, and climate action.

Shachi Singh

MANAGING DIRECTOR

LLR Educational Trust

LR Group of Institutes, Solan

Preface

It gives us immense pleasure to present the Abstract Book of the Environment Conclave & Himachal Climate Action Award 2026, organized by the LR Group of Institutes, Solan, under the aegis of the LLR Educational Trust, Solan. This volume brings together a diverse collection of research abstracts that reflect contemporary innovations, scientific advancements, and practical solutions aimed at addressing global environmental and climate challenges.

The conclave serves as an interdisciplinary platform for researchers, academicians, industry experts, policymakers, professionals, and students to exchange ideas and showcase research that promotes environmental sustainability and climate resilience. The abstracts included in this publication span a wide range of themes, including Climate Science and Natural Ecosystems; Green Economy, Policy and Governance; Clean Technologies, Energy and Smart Infrastructure; Circular Systems and Resource Sustainability; and Sustainable Communities, Health and Lifestyle. Together, they demonstrate the collective commitment of the scientific community toward developing sustainable strategies for environmental conservation and responsible development.

This abstract book not only highlights emerging research but also encourages collaboration across disciplines, fostering innovative approaches to climate action and sustainable resource management. The contributions presented herein are expected to inspire meaningful discussions, generate new partnerships, and support evidence-based policies and practices aligned with national priorities and the United Nations Sustainable Development Goals (SDGs).

We express our sincere appreciation to all authors for their valuable contributions, the reviewers for their scholarly evaluations, and the organizing committee for their dedicated efforts in making this conclave a success. We also acknowledge the support of our institutional partners, collaborators, and participants whose enthusiasm has strengthened this initiative.

We hope this compilation serves as a valuable academic resource and inspires continued research, innovation, and collective action toward building a more sustainable, resilient, and environmentally responsible future.

ORGANIZING COMMITTEE

Environment Conclave & Himachal Climate Action Award 2026
LR Group of Institutes, Solan



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ECHCAA/2026/001

Plastic Waste and Microplastics: Pharmaceutical Packaging's Environmental Legacy

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Abstract

Pharmaceutical packaging represents a critical yet understudied source of environmental pollution. This investigation evaluates the ecological consequences of plastic based pharmaceutical packaging and the emergence of microplastics in aquatic and terrestrial ecosystems. The pharmaceutical industry generates approximately 3 million tons of plastic waste annually through blister packs, bottles, and injectable containers. Our research demonstrates that single dose packaging prevalent in developed countries significantly increases per unit plastic waste. Ninety four percent of pharmaceutical packaging plastic is not recycled, creating persistent pollution problems. Microplastics from degraded pharmaceutical packaging have been detected in drinking water, soil, and marine organisms at concerning concentrations. The study involved analyzing 200 water treatment facilities and found trace amounts of packaging related polymers in 87% of treated wastewater samples. We identified that polypropylene and polyvinyl chloride dominate pharmaceutical packaging despite better alternatives. The research quantifies the bioaccumulation potential of microplastics in food chains and their observed toxicological effects on aquatic fauna. Our findings demonstrate that transitioning to biodegradable, compostable, or refillable packaging systems could reduce environmental burden by 60-75%. This abstract advocates for regulatory mandates requiring pharmaceutical companies to adopt sustainable packaging innovations and establish comprehensive producer responsibility schemes for end-of-life pharmaceutical packaging disposal.

Keywords: Pharmaceutical packaging, Plastic waste, Microplastics, Pollution, Bioaccumulation, Circular economy



Abstract Book

ECHCAA/2026/002

Pharmaceutical Pollution and Its Cascading Effects on Climate Vulnerable Aquatic Ecosystems

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Abstract

The discharge of active pharmaceutical ingredients (APIs) into aquatic environments has garnered increasing scientific attention, particularly in the context of climate change-induced ecological stressors. Rising global temperatures, altered precipitation patterns, and extreme hydrological events compound the bioaccumulation and persistence of pharmaceuticals in freshwater and marine ecosystems. This abstract investigates how climate variability amplifies pharmaceutical contamination risks, with a focus on antibiotics, endocrine disruptors, and analgesics detected in rivers, lakes, and coastal waters globally. Elevated water temperatures accelerate the metabolic rates of aquatic organisms, intensifying their exposure to sub lethal pharmaceutical concentrations. Concurrently, climate driven drought conditions reduce dilution capacity in water bodies, increasing pollutant concentrations. The abstract highlights case studies from South Asian river systems, where pharmaceutical manufacturing effluents combined with reduced monsoon flows have resulted in antibiotic resistance hotspots. Advanced oxidative processes (AOPs), constructed wetlands, and membrane bioreactors are evaluated as climate resilient remediation technologies. Furthermore, regulatory gaps in pharmaceutical environmental risk assessments (ERA) within the framework of the European Medicines Agency (EMA) and the WHO are critically examined. The abstract concludes by advocating for integrated environmental monitoring programs that account for climate projections in pharmaceutical risk modeling, thereby enabling proactive governance of pharmaceutical pollution under changing climatic conditions.

Keywords: Pharmaceutical, Pollution, Climate, Aquatic, Ecosystems



ECHCAA/2026/003

Advancing Climate Science Research and Ecological Solutions for Sustainable Environmental Resilience

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Abstract

Environmental sustainability, biodiversity conservation, and human well-being are all seriously threatened by climate change. The demand for evidence-based climate science research and practical ecological solutions has increased due to rising global temperatures, harsh weather, and ecosystem degradation. This study looks at current developments in climate science with an emphasis on how resource exploitation, land-use changes, and greenhouse gas emissions affect natural ecosystems. It looks deeper into ecological solutions such as biodiversity protection tactics, afforestation, sustainable agriculture, ecosystem restoration, and nature-based climate adaptation. The study emphasizes how community involvement, legislative changes, and scientific advancements can reduce climate risks and improve ecological resilience. Results indicate that carbon sequestration, ecosystem regeneration, and sustainable development can all be greatly aided by combining climate research with ecological management techniques. In order to achieve long-term environmental sustainability and climate resilience, the study highlights the significance of cooperative effort among governments, researchers, businesses, and local communities.

Keywords: Climate Change, Climate Science, Ecological Solutions, Sustainability, Biodiversity Conservation, Ecosystem Restoration, Carbon Sequestration, Climate Resilience.



Abstract Book

ECHCAA/2026/004

Biodiversity Conservation and Ecological Restoration

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Abstract

Biodiversity conservation and ecological restoration are essential strategies for addressing the growing environmental challenges caused by habitat destruction, climate change, pollution, invasive species, and unsustainable resource use. Biodiversity encompasses the variety of life forms, including plants, animals, microorganisms, and the ecosystems they inhabit. The conservation of biodiversity is critical for maintaining ecosystem stability, supporting ecological processes, and ensuring the continued provision of ecosystem services such as food production, water purification, carbon sequestration, and climate regulation. Restoration practices include reforestation, wetland rehabilitation, soil improvement, invasive species control, and the reintroduction of native species. These actions help restore ecological functions, enhance habitat quality, and increase the resilience of ecosystems to environmental disturbances. Successful restoration projects not only improve biodiversity but also contribute to socioeconomic benefits by supporting sustainable livelihoods, enhancing natural resource availability, and promoting environmental awareness among local communities. Recent advances in restoration ecology emphasize the integration of scientific research, traditional ecological knowledge, and community participation. Nature-based solutions have emerged as effective approaches for achieving both biodiversity conservation and climate adaptation goals. In a long term there should be a collaborative effort among governments, researchers, non-governmental organizations, local communities, and the private sector. Effective policy implementation, public engagement, and adaptive management strategies are crucial for achieving conservation and restoration objectives. In conclusion, biodiversity conservation and ecological restoration are interconnected approaches that support ecological integrity, environmental sustainability, and human well-being. By protecting existing ecosystems and restoring degraded landscapes, societies can enhance ecosystem resilience, mitigate climate change impacts, and safeguard natural resources for future generations.

Keywords: Biodiversity Conservation, Ecological Restoration, Ecosystem Services, Climate Change, Sustainable Development, Habitat Restoration, Nature-Based Solutions.



Abstract Book

ECHCAA/2026/005**Healthcare Waste Management in the Context of Environmental Sustainability**

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Abstract

Hospitals generate substantial volumes of hazardous, infectious, pharmaceutical, and general waste streams whose inadequate management poses significant environmental contamination risks, undermining ecological integrity and community health in the very communities' healthcare systems are mandated to protect. This paper examines healthcare waste generation rates, composition profiles, and disposal practices across public and private hospital sectors in fifteen countries, assessing environmental contamination outcomes and identifying systemic reform priorities. Data indicate that hospitals generate between 0.5 and 7.6 kilograms of total waste per occupied bed per day, with wide variation attributable to income level differences, clinical specialization mix, and waste segregation compliance. Pharmaceutical waste including expired medications, chemotherapy residues, and antibiotic compounds was identified as a critical environmental contaminant, with monitoring of hospital adjacent water bodies revealing measurable concentrations of ciprofloxacin, diclofenac, and endocrine disrupting compounds that persisted through municipal wastewater treatment processes. Incineration of clinical waste without adequate emission controls generated dioxin and furan releases detected in surrounding soil and vegetation up to three kilometers from facility boundaries. Single use plastic proliferation, accelerated by infection control protocols during recent pandemic responses, has compounded waste volume challenges without proportionate investment in sustainable alternatives. Promising reform approaches documented include pharmaceutical take back and safe disposal programmes, high temperature autoclave adoption replacing open incineration, and procurement policies prioritising reusable medical equipment where clinical safety permits. Regulatory enforcement of waste manifest systems and mandatory environmental impact reporting for healthcare facilities emerged as the strongest predictor of improved compliance outcomes across national contexts studied.

Keywords: Healthcare waste management, pharmaceutical contamination, Hospital environmental impact, Waste segregation, Water contamination



ECHCAA/2026/006

Herbal Agroforestry Systems as Dual-Purpose Solutions for Climate Mitigation and Sustainable Phytomedicine Production

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Abstract

Herbal agroforestry the intentional integration of medicinal and aromatic plants within diversified tree-crop systems is gaining recognition as a dual-purpose strategy that simultaneously addresses climate change mitigation and the growing global demand for sustainably sourced plant-based medicines. This paper presents findings from a multi-site comparative analysis of herbal agroforestry systems across South and Southeast Asia, evaluating carbon sequestration potential, soil health outcomes, microclimate regulation, and medicinal herb yield quality relative to monoculture herb cultivation. Results indicate that stratified agroforestry plots incorporating species such as *Centella asiatica*, *Andrographis paniculata*, and *Stevia rebaudiana* beneath canopy trees achieved carbon stocks 2.3 to 4.1 times higher than open monocultures, while maintaining commercially viable herb yields with significantly reduced agrochemical inputs. Canopy shading moderated soil surface temperatures by 3.8–6.2°C during peak summer months, creating buffered microclimates that protected heat-sensitive herb species from climate-induced phenological disruption. Crucially, herbs grown within agroforestry systems exhibited superior phytochemical profiles, with flavonoid and essential oil concentrations elevated by 18–34% compared to full-sun monoculture equivalents, attributable to moderate shade-induced secondary metabolite stimulation. Water retention in agroforestry soils was significantly improved through enhanced organic matter accumulation, reducing irrigation dependency by approximately 28% across sites. Economic modeling demonstrates positive net present values for herbal agroforestry adoption over ten-year investment horizons, particularly where carbon credit markets are accessible. These findings support herbal agroforestry as a scalable, evidence-based intervention at the nexus of climate action and medicinal plant conservation.

Keywords: Agroforestry, Carbon sequestration, Phytomedicine, Microclimate regulation, Sustainable agriculture



ECHCAA/2026/007

Deforestation, Habitat Fragmentation, and the Accelerating Erosion of Ethnomedicinal Plant Diversity in Tropical Ecosystems

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Abstract

Tropical and subtropical forests harbor the majority of the world's documented medicinal plant species, yet accelerating deforestation and habitat fragmentation are driving unprecedented losses of ethnobotanical diversity at a pace that outstrips scientific documentation. This paper investigates the ecological and sociocultural consequences of forest clearance on medicinal plant availability in three biodiversity hotspots the Western Ghats, the Amazon Basin, and the Congo Forest Belt drawing on field surveys, herbarium records, and indigenous knowledge assessments conducted over a fifteen-year monitoring period. Findings reveal that edge effect disturbances associated with fragmentation disproportionately affect shade-dependent medicinal understory species, with populations of high-value plants such as *Nothapodytes foetida* and *Rauvolfia serpentina* declining by 40–78% in fragmented landscapes relative to intact forest controls. Microclimate alterations including elevated temperature, reduced humidity, and increased solar radiation penetration within forest fragments create conditions incompatible with the germination and establishment requirements of numerous specialist medicinal species. Simultaneously, the displacement of indigenous and forest dependent communities severs intergenerational transmission of ethnopharmacological knowledge, resulting in a dual extinction biological and cultural that quantitative biodiversity metrics alone fail to capture. Community based conservation models integrating sacred grove protection, in situ gene banking, and benefit sharing agreements with bioprospecting entities demonstrate measurable success in buffering medicinal plant diversity against deforestation pressure. Policy recommendations include embedding medicinal plant conservation within national REDD+ frameworks and recognizing indigenous biocultural rights in international biodiversity instruments.

Keywords: Deforestation, Ethnobotany, Biodiversity loss, Habitat fragmentation, Tropical forests



ECHCAA/2026/008

Environmental Pollutants and Herbal Contamination

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Abstract

The intersection of environmental degradation and herbal medicine quality presents an escalating public health concern, as medicinal plants growing in polluted landscapes accumulate heavy metals, pesticide residues, and atmospheric particulates that compromise both safety and efficacy. This study evaluates the uptake mechanisms of cadmium, lead, arsenic, and mercury in ten commonly traded medicinal herbs including *Mentha piperita*, *Echinacea purpurea*, and *Curcuma longa* cultivated across industrial, peri urban, and agricultural environments with varying contamination profiles. Results demonstrate that rhizospheric soil chemistry is the primary determinant of heavy metal bioavailability, with acidic, low organic matter soils facilitating significantly higher root to shoot translocation factors. Aerial deposition of particulates from vehicular emissions and coal combustion was found to contribute substantially to lead and cadmium loading on leaf surfaces, particularly in herbs harvested within 500 metres of major roadways. Critically, conventional washing protocols reduced surface contamination by only 35–62%, leaving systemic accumulation unaddressed. Seasonal variation in pollutant uptake was also documented, with summer harvests showing elevated concentrations correlating with reduced precipitation and increased dust loading. Mitigation strategies explored include phyto remediation compatible crop rotation, biochar soil amendments, and geographic information system-based risk mapping for harvest site certification. Regulatory frameworks governing maximum residue limits require urgent updating to reflect contemporary environmental contamination realities, and traceability systems must be strengthened across global herbal supply chains.

Keywords: Heavy metals, Phyto remediation, Medicinal herb safety, Environmental pollution, Bioaccumulation



Abstract Book

ECHCAA/2026/009

Climate Change and Medicinal Herb Phytochemistry

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Abstract

Climate change is fundamentally altering the biochemical composition of medicinal herbs, with rising temperatures, erratic precipitation, and elevated CO₂ levels reshaping the secondary metabolite profiles that underpin their therapeutic value. This review synthesizes current evidence on how thermal stress and altered moisture regimes influence the concentration and diversity of bioactive compounds including alkaloids, flavonoids, terpenes, and phenolic acids across widely cultivated medicinal species such as *Ocimum sanctum*, *Glycyrrhiza glabra*, and *Withaniasomnifera*. Under elevated temperatures, many herbs exhibit accelerated phenological cycles, resulting in premature senescence and reduced accumulation of pharmacologically active compounds. Conversely, moderate CO₂ enrichment has been shown to stimulate biomass production in certain species, though this increase in vegetative growth often dilutes secondary metabolite concentrations, creating a paradox for herbalists and pharmaceutical producers alike. Drought stress, increasingly prevalent in semi-arid cultivation zones, triggers upregulation of specific antioxidant pathways, temporarily elevating essential oil and resin content before causing cellular degradation. Geographical range shifts of key medicinal plants further complicate sustainable sourcing, as populations adapted to specific microclimates lose competitive advantage in altered thermal regimes. The review highlights critical research gaps in longitudinal phytochemical monitoring under controlled climate scenarios and calls for the development of climate-resilient cultivars without compromising medicinal efficacy. Integrating traditional ecological knowledge with precision agronomy may offer viable adaptive strategies for the herbal medicine sector facing an uncertain climatic future.

Keywords: Phytochemistry, Thermal stress, Secondary metabolites, Medicinal plants, Climate adaptation



Abstract Book

ECHCAA/2026/010**GREEN ECONOMY, POLICY AND GOVERNANCE**

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Abstract

The green economy has emerged as a transformative approach to achieving sustainable development by integrating economic growth, environmental protection, and social equity. As nations face increasing challenges related to climate change, resource depletion, environmental degradation, and economic instability, the green economy offers a framework for promoting low carbon, resource efficient, and socially inclusive development. This concept emphasizes that economic progress and environmental sustainability are not conflicting objectives but complementary goals that can be pursued simultaneously through appropriate policies, governance mechanisms, and technological innovations. In India, rapid industrialization and economic growth have significantly improved living standards; however, these advances have also intensified environmental pressures and the overexploitation of natural resources. Consequently, the transition toward a green and decarbonized economy has become a strategic necessity. Effective green governance plays a critical role in facilitating this transition through policy instruments such as environmental regulations, carbon pricing, sustainable infrastructure investments, renewable energy promotion, circular economy practices, and institutional reforms. The green economy is closely linked with the broader concepts of sustainable development, which seeks to balance economic prosperity, social inclusion, and environmental stewardship while ensuring intergenerational equity. This article examines the evolution of the green economy concept, its relationship with sustainable development, and the role of governance and public policy in driving sustainable transformation. Furthermore, it highlights the opportunities, challenges, and policy implications associated with implementing green economic strategies, particularly in developing countries. The study concludes that strengthening institutional capacity, promoting innovation, and fostering international cooperation are essential for achieving long term environmental sustainability and inclusive economic growth.

Keywords: Green Economy, Green Governance, Sustainable Development, Environmental Sustainability, Decarbonization, Public Policy



ECHCAA/2026/011

**ORANGE PEEL-BASED MOSQUITO REPELLENT SPRAY: A SUSTAINABLE
APPROACH FOR ENVIRONMENTAL HEALTH PROTECTION**

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Abstract

Mosquito-borne diseases remain a significant environmental health challenge worldwide, while the extensive use of synthetic chemical repellents raises concerns regarding environmental contamination and human health risks. Orange peel (*Citrus sinensis*), an abundant agro-industrial waste, represents a valuable source of bioactive compounds with potential applications in sustainable vector control. This review highlights the environmental and public health significance of orange peel-based mosquito repellent sprays, focusing on their phytochemical composition, extraction methods, formulation strategies, and repellent efficacy. Orange peel essential oil is rich in limonene, flavonoids, and other phenolic compounds that exhibit mosquito repellent, antimicrobial, antioxidant, and biodegradable properties. Utilization of orange peel waste for repellent production supports circular economy principles by converting agricultural waste into value-added products while reducing environmental burden. Compared with conventional synthetic repellents, orange peel-based formulations offer a safer, eco-friendly, and sustainable alternative with lower ecological impact. The review further discusses quality control parameters, safety considerations, environmental benefits, and future prospects for community-level mosquito management programs. Adoption of natural repellents derived from citrus waste can contribute to integrated vector control strategies, environmental conservation, and improved public health outcomes. The study underscores the potential of orange peel-derived repellents as an innovative solution linking waste valorization, environmental sustainability, and disease prevention.

Keywords: Environmental Health, Orange Peel Waste, Sustainable Vector Control, Natural Mosquito Repellent, Circular Economy, Citrus Essential Oil, Limonene, Public Health, Waste Valorization, Eco-friendly Formulation.



ECHCAA/2026/012

GREEN ECONOMY, POLICY AND GOVERNANCE

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Abstract

This abstract examines the intersection of pharmaceutical manufacturing and environmental degradation as an often-overlooked contributor to climate change. The global pharmaceutical industry generates substantial waste streams, including chemical residues, wastewater, and unreacted reagents that contaminate aquatic ecosystems and soil systems worldwide. These pollutants compromise biodiversity and alter biogeochemical cycles, ultimately accelerating climate instability. Pharmaceutical residues in water bodies, such as hormones and antibiotics, disrupt microbial communities essential for nutrient cycling and carbon sequestration, reducing ecosystems' capacity to mitigate atmospheric carbon dioxide. Additionally, the energy intensive synthesis of active pharmaceutical ingredients contributes significantly to industrial carbon emissions. This review synthesizes current evidence demonstrating that pharmaceutical pollution represents a dual environmental threat: direct contamination requiring remediation resources and indirect climate acceleration through ecosystem disruption. We propose that circular economy principles, green chemistry methodologies, and sustainable manufacturing practices within the pharmaceutical sector could substantially reduce this environmental burden. Implementation of stricter regulations, investment in cleaner production technologies, and development of biodegradable alternatives to persistent pharmaceuticals are critical interventions. Furthermore, integrating pharmacological research with climate science enables the identification of synergistic solutions where pharmaceutical advances simultaneously address both health crises and climate mitigation. This work underscores the necessity for interdisciplinary collaboration to transform the pharmaceutical industry into a climate positive sector.

Keywords: Pharmaceutical waste, Environmental contamination, Climate change mitigation, Sustainable manufacturing, green chemistry



Abstract Book

ECHCAA/2026/013

Climate Responsive Pharmacology: Drug Development for Climate Related Health Emergencies

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Abstract

Climate change intensifies heat related illnesses, vector-borne diseases, and mental health disorders, necessitating novel pharmacological interventions tailored to climate induced health threats. This abstract evaluates the emerging field of climate responsive pharmacology, which prioritizes drug development addressing pathologies, amplified by climate change, including heat exhaustion, dengue fever, malaria, and climate anxiety. Rising global temperatures expand the geographic range of disease vectors, creating urgent demand for anti-malarial, anti-viral, and vector-control therapeutics adapted to tropical climates and resource limited settings. Simultaneously, pharmacological research increasingly addresses psychological impacts of climate distress and environmental disruption. We discuss innovative approaches including repositioning existing drugs, developing climate resilient pharmaceutical supply chains, and creating medications effective under varied environmental conditions. Advanced delivery systems and formulations resistant to temperature fluctuations are essential for regions with inadequate refrigeration infrastructure. Case studies demonstrate successful adaptations of antihypertensive and antipyretic medications for climate vulnerable populations. The abstract highlights partnerships between pharmaceutical companies, government agencies, and climate scientists as catalysts for rapid development and deployment of climate responsive therapeutics. Challenges include patent considerations, affordability, and equitable access in developing nations bearing disproportionate climate burden. Strategic investments in climate pharmacology represent proactive health security measures, reducing mortality and morbidity while strengthening population resilience against climate impacts.

Keywords: Climate responsive drugs, Vector borne disease, Drug development, Pharmacological innovation, Climate health security



Abstract Book

ECHCAA/2026/014**Carbon Neutral Pharmaceutical Manufacturing and Industrial Decarbonization Strategies**

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Abstract

The pharmaceutical manufacturing sector accounts for approximately 5% of global industrial carbon emissions, making sustainable production practices crucial for climate mitigation. This abstract explores decarbonization strategies within pharmaceutical manufacturing, including renewable energy integration, process optimization, waste heat recovery, and transition toward environmentally benign synthesis pathways. Conventional pharmaceutical production involves multi step syntheses generating significant carbon footprints through energy consumption and chemical waste. Green pharmaceutical chemistry redesigns molecular synthesis using catalytic reactions, bio-based feedstocks, and solvent alternatives, reducing emissions by 30-50% compared to conventional methods. Case analyses of leading pharmaceutical companies implementing net zero initiatives reveal feasibility and cost effectiveness of renewable energy adoption, circular supply chains, and waste valorization. Emerging technologies including continuous manufacturing, micro reactor systems, and computational chemistry accelerate development of lower impact production methods. Regulatory frameworks and industry standards increasingly mandate sustainability reporting and emissions reduction targets. However, balancing pharmaceutical innovation with environmental responsibility requires investment in research infrastructure, workforce training, and international cooperation. Block chain and digital traceability systems enable transparent carbon accounting throughout supply chains. This review demonstrates that pharmaceutical industry decarbonization represents both climate imperative and economic opportunity, potentially reducing operational costs while achieving net zero targets. Collaborative efforts between regulators, manufacturers, researchers, and stakeholders are essential for transforming pharmaceutical production into a climate solution.

Keywords: Pharmaceutical manufacturing, Carbon emissions, Green chemistry, Industrial sustainability, Net zero targets



ECHCAA/2026/015

Pharmaceutical Waste and Environmental Contamination as a Climate Change Factor

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Abstract

This abstract examines the intersection of pharmaceutical manufacturing and environmental degradation as an often-overlooked contributor to climate change. The global pharmaceutical industry generates substantial waste streams, including chemical residues, wastewater, and unreacted reagents that contaminate aquatic ecosystems and soil systems worldwide. These pollutants compromise biodiversity and alter biogeochemical cycles, ultimately accelerating climate instability. Pharmaceutical residues in water bodies, such as hormones and antibiotics, disrupt microbial communities essential for nutrient cycling and carbon sequestration, reducing ecosystems' capacity to mitigate atmospheric carbon dioxide. Additionally, the energy intensive synthesis of active pharmaceutical ingredients contributes significantly to industrial carbon emissions. This review synthesizes current evidence demonstrating that pharmaceutical pollution represents a dual environmental threat: direct contamination requiring remediation resources and indirect climate acceleration through ecosystem disruption. We propose that circular economy principles, green chemistry methodologies, and sustainable manufacturing practices within the pharmaceutical sector could substantially reduce this environmental burden. Implementation of stricter regulations, investment in cleaner production technologies, and development of biodegradable alternatives to persistent pharmaceuticals are critical interventions. Furthermore, integrating pharmacological research with climate science enables the identification of synergistic solutions where pharmaceutical advances simultaneously address both health crises and climate mitigation. This work underscores the necessity for interdisciplinary collaboration to transform the pharmaceutical industry into a climate positive sector.

Keywords: Pharmaceutical waste, Environmental contamination, Climate change mitigation, Sustainable manufacturing, green chemistry



Abstract Book

ECHCAA/2026/016

Strategies To Minimize the Toxic Effect of Biomedical Waste and Legal Issues

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Abstract

Biomedical waste management (BMWM) in India presents substantial issues that require deliberate solutions. Proper biological waste management is crucial for protecting public health and the environment as the healthcare sector grows. Bio-Medical waste from healthcare facilities poses a risk to human health and the environment if not properly disposed. Biomedical waste generated during COVID-19 diagnosis, isolation, and treatment poses a risk of introducing new infections; hence it needs special consideration. To effectively address BMWM, a collaborative approach is necessary, including government support for finance and infrastructure development, dedicated healthcare workers and facilities, ongoing monitoring of BMW practices, strict legislation, and strong regulatory bodies. The Biomedical Waste Management Rules, 2016 (BMWM Rules, 2016) mandate that all healthcare facilities take all necessary safeguards to guarantee that BMW is handled without having a harmful influence on people's health or the environment. The six schedules in this document include the BMW category, the type and colour coding of the containers, and labels for BMW bags or containers that must be visible and non-washable. The schedule includes the standard for treatment and disposal, a label indicating the locations of waste treatment facilities like autoclaves and incinerators as well as the shipping of BMW containers. The new regulations in India are intended to enhance BMW treatment, transportation, disposal, and segregation. Because BMW has the potential to pollute the air, water, and land if improperly managed, this appropriate management is meant to reduce environmental contamination. The successful disposal of BMW requires a lot of cooperation as well as dedicated government funding and infrastructure development. Thus, creating eco-friendly techniques and the appropriate plan and procedures for BMW disposal are crucial to achieving the objective of a clean and green environment. This review article's goal is to present an organised, thorough analysis of BMW together with methodical, evidence-based information.

Key words: Biomedical Waste Management, Healthcare Waste, Biomedical Waste Rules 2016, Waste Segregation, Environmental Protection, COVID-19 Medical Waste.



Abstract Book

ECHCAA/2026/017**Nutrition Garden-Harbinger of Greener and Healthier Future**

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Abstract

Amidst rising global food insecurity and population growth, nutrition gardens have emerged as essential local food systems. The world's population is expected to exceed 9 billion by 2050, and nearly 53% of India's population will be urban. The study examines the role of nutrition gardens in enhancing household food security and nutrition, particularly for the urban poor. Defined as small-scale, bio diverse production systems situated near dwellings, nutrition gardens offer significant social, economic, and environmental benefits. Socially, they provide direct access to essential vitamins and minerals; economically, they reduce household costs and generate income; and environmentally, they promote waste recycling and biodiversity. A successful initiative by the NGO Ehsaas in Lucknow is highlighted, where "bori baggiya" (grow bags) and organic waste disposal kits were used to empower families living in urban slums to grow fresh vegetables in limited spaces. The findings suggest that nutrition gardens are sustainable and eco-friendly agricultural practices with considerable potential to improve food and nutritional security. However, more empirical research is needed to fully assess their economic value and effectiveness during crisis situations.

Keywords: Nutrition Garden, Food Security, Urban Agriculture, Household Nutrition, Local Food Systems, Dietary Diversity, Sustainable Agriculture, Developing Countries



Abstract Book

ECHCAA/2026/018

Climate Change and Public Health: Emerging Challenges and Adaptive Strategies

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Abstract

One of the biggest risks to public health worldwide in the twenty-first century is increasingly acknowledged to be climate change. Numerous health effects are being caused by rising average temperatures, changing precipitation patterns, and an increase in the frequency and severity of extreme weather events. These include illnesses brought on by the heat, respiratory and cardiovascular conditions, injuries and fatalities from extreme weather events like storms and floods, and the spread of vector borne infections like dengue and malaria. Malnutrition and infectious disease burdens are also made worse by indirect consequences like food and water instability, especially in groups that are already at risk. Adapting to these changes is becoming increasingly difficult for public health systems, particularly in low- and middle-income areas with limited resources. Additionally, current health disparities are exacerbated by climate change, disproportionately impacting. Additionally, children, the elderly, outdoor labourers, and vulnerable communities are disproportionately affected by climate change, which exacerbates already existing health disparities. Furthermore, there is growing evidence of the effects of climate related disasters on mental health, including anxiety, sadness, and post-traumatic stress disorder. In order to address these issues, comprehensive solutions combining improved public health infrastructure with climate mitigation and adaptation tactics are needed. Essential elements of preparedness include community-based interventions, climate-resilient healthcare facilities, and early warning systems. To lower hazards and safeguard public health, cooperation across industries like the environment, energy, agriculture, and health is essential. In the end, proactive policy measures can greatly lessen the negative health effects of climate change and advance resilient, sustainable civilizations.

Keywords: Climate Change, Public Health, Extreme Weather Events, Heat-Related Illnesses, Vector-Borne Diseases, Air Pollution, Food Insecurity



ECHCAA/2026/019

Green Pharmacy and Sustainable Pharmaceutical Design: Reducing the Environmental Footprint of Medicines

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Abstract

The concept of green pharmacy inspired by the broader principles of green chemistry, advocates for a fundamental transformation in how pharmaceutical compounds are designed, manufactured, used, and disposed of in order to minimize their environmental footprint throughout the entire product lifecycle. As evidence of widespread pharmaceutical contamination of ecosystems continues to accumulate, there is growing recognition that environmental considerations must be integrated into drug development processes from the earliest stages, rather than treated as an afterthought in post-market risk management. At the molecular design level, the benign by design philosophy encourages medicinal chemists to engineer pharmaceutical compounds that retain their therapeutic efficacy while incorporating structural features that promote rapid environmental degradation after excretion. This includes designing molecules susceptible to photolysis, hydrolysis, or microbial biodegradation under environmental conditions, reducing the likelihood of bioaccumulation in aquatic and terrestrial food chains, and minimizing endocrine disrupting potential. Advances in computational chemistry, quantitative structure activity relationship (QSAR) modeling, and *in silico* environmental fate prediction now offer powerful tools to screen candidate drug molecules for environmental risk at the design phase, before costly synthesis and testing. Green manufacturing practices represent another critical dimension. The pharmaceutical industry consumes vast quantities of organic solvents, water, and energy, generating hazardous waste streams that may include pharmaceutical intermediates and active ingredients. Adopting principles of atom economy, catalytic synthesis, solvent substitution, process intensification, and closed-loop manufacturing can substantially reduce the environmental burden of pharmaceutical production. Environmental Management Systems (EMS) and extended producer responsibility schemes further incentivize manufacturers to account for the full lifecycle environmental impact of their products. Regulatory frameworks are gradually evolving to incorporate environmental considerations into drug approval processes. The European Medicines Agency (EMA) mandates environmental risk assessments for new human medicines, and similar requirements are expanding globally. Eco-labeling schemes, pharmaceutical take-back programs, and patient education initiatives round out a comprehensive strategy to reduce the environmental pharmaceutical footprint. Ultimately, achieving sustainable pharmaceutical development will require concerted collaboration among chemists, pharmacologists, environmental scientists, regulators, industry, and civil society to embed environmental stewardship at the heart of pharmaceutical innovation.

Keywords: Green pharmacy, Sustainable drug design, Benign by design, pharmaceutical lifecycle, Environmental risk assessment



Abstract Book

ECHCAA/2026/020

AI-Driven Green Pharmacy: Advancing Sustainable Healthcare Through Drug Repurposing, Eco-Friendly Drug Development, and Pharmaceutical Waste Reduction

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Abstract

The environmental impact of pharmaceutical manufacturing, consumption, and disposal has become a growing concern for global sustainability and climate action. Pharmaceutical residues, hazardous chemical waste, and improper disposal of unused medicines contribute to environmental pollution, antimicrobial resistance, and ecosystem damage. Green Pharmacy has emerged as a sustainable approach that seeks to minimize the environmental footprint of pharmaceuticals while maintaining effective healthcare delivery. Green Pharmacy promotes environmentally responsible practices throughout the pharmaceutical lifecycle, including green chemistry-based drug development, eco-friendly manufacturing, sustainable prescribing, and safe disposal of medicines. Strategies such as biodegradable formulations, reduced solvent consumption, energy-efficient production processes, and pharmaceutical take-back programs can significantly reduce environmental contamination and support sustainable healthcare systems. A major innovation within Green Pharmacy is the application of Artificial Intelligence (AI) in drug discovery and drug repurposing. AI-driven drug repurposing identifies new therapeutic uses for existing drugs, reducing the need for extensive laboratory experimentation, chemical synthesis, and resource-intensive research. This approach accelerates drug development while lowering energy consumption, chemical waste generation, and associated carbon emissions. Furthermore, eco-directed sustainable prescribing practices encourage the selection of therapeutically effective medicines with lower environmental impact. The integration of AI technologies with Green Pharmacy principles offers a novel framework for achieving sustainable healthcare and environmental stewardship. These approaches align with the United Nations Sustainable Development Goals, particularly those focused on health, responsible consumption, and climate action. In conclusion, AI-driven Green Pharmacy represents a promising pathway toward a greener healthcare future by combining innovative drug repurposing, eco-friendly pharmaceutical development, and responsible waste management to protect both human and planetary health.

Keywords: Green Pharmacy, Artificial Intelligence, Drug Repurposing, Sustainable Healthcare, Green Chemistry, Pharmaceutical Waste Management, Climate Action, Environmental Sustainability.



ECHCAA/2026/021

Climate Change as a Driver of Pharmaceutical Pollution Dynamics: Emerging Risks and Adaptive Challenges

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Abstract

The intersection of climate change and pharmaceutical pollution represents an increasingly critical frontier in environmental science. While the presence of pharmaceutical residues in the environment has been extensively documented, the ways in which climate change will modify the fate, transport, behavior, and ecological impacts of these contaminants remain incompletely understood. A growing body of evidence suggests that climate-driven alterations to the hydrological cycle, temperature regimes, extreme weather events, and ecosystem functioning will fundamentally reshape pharmaceutical pollution dynamics, with potentially serious consequences for both environmental and public health. Rising temperatures exert dual and sometimes contradictory effects on pharmaceuticals in the environment. On one hand, elevated temperatures can accelerate the biodegradation of certain pharmaceutical compounds in aquatic and terrestrial systems, potentially reducing persistence. On the other hand, higher temperatures enhance the volatilization and atmospheric transport of semi-volatile pharmaceuticals, extend the biological activity of temperature-sensitive compounds, and promote the growth of pharmaceutical-resistant microbial populations. Warmer waters also increase the metabolic rates of aquatic organisms, potentially amplifying the toxic effects of pharmaceutical mixtures at existing environmental concentrations. Altered precipitation patterns and extreme hydrological events including droughts and flooding will profoundly affect pharmaceutical transport dynamics. Drought conditions concentrate pharmaceutical residues in reduced water volumes, elevating exposure risks for aquatic biota. Conversely, intense rainfall events and flooding mobilize pharmaceutical-laden soils and sediments, transporting contaminants to previously unaffected ecosystems and drinking water sources. Permafrost thaw in Arctic and subarctic regions may release legacy pharmaceutical contaminants previously sequestered in frozen soils, introducing these compounds into pristine northern ecosystems. Adaptive challenges are substantial. Existing environmental risk assessment models and regulatory frameworks do not adequately account for climate change interactions with pharmaceutical pollutants. Future strategies must integrate climate projections into pharmaceutical environmental risk assessments, invest in climate-resilient water treatment infrastructure, and develop early warning systems for pharmaceutical contamination events driven by extreme weather. Interdisciplinary collaboration across pharmacology, environmental science, climatology, and public health policy will be indispensable in navigating these compounding environmental challenges.

Keywords: Climate change, pharmaceutical pollution, Hydrological cycle, Environmental fate, Water quality



Abstract Book

ECHCAA/2026/022**Intelligent Transportation Systems for Sustainable Urban Development**

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Abstract

There has been rapid urbanization resulting in increased need for transportation in various cities around the globe. In 2050, it is expected that about 70% of the population will reside in cities, leading to such issues as traffic jams, wastage of fuel, and environmental pollution. There is also a significant number of emissions caused by transportation systems that contribute to climate change. As a consequence, there is a need for improved transport systems that include buses, trains, bicycles, and electric cars in order to facilitate travel and reduce environmental damage. This study focuses on intelligent transportation systems that have been used to increase sustainability in cities. ITS uses advanced technological methods that include sensing, communication networks, artificial intelligence, and internet of things. It helps to monitor traffic flow and provides travel information to citizens. Consequently, sustainable urban transport systems can easily be created through ITS. In the context of the topic under discussion, the role of intelligent transportation systems (ITS) in enhancing urban mobility and ensuring sustainable urban development will be analyzed. This paper relies on an extensive literature review of the previous studies and relevant examples of implementation of smart city initiatives. It is evident that the application of advanced intelligent transportation systems can decrease traffic congestion and save energy and fuel consumption, which will lead to lower air pollution rates. For instance, the implementation of adaptive traffic signals can increase transportation efficiency. In addition, it is possible to benefit from the implementation of smart mobility solutions and shared transportation services that will allow reducing personal vehicle use and promote sustainable city planning. Nonetheless, there are certain challenges associated with ITS usage in urban areas. Namely, the costs of infrastructure installation and maintenance can be extremely high. Besides, ITS can raise serious security concerns. Moreover, there is always a risk of losing personal data when using smart mobility services. Therefore, these issues must be resolved. In conclusion, Intelligent Transportation Systems can play an important role in creating smarter, cleaner, and more sustainable cities. With proper planning and implementation, ITS can improve urban mobility, reduce environmental impacts, and support long term sustainable urban development.

Keywords: Intelligent Transportation Systems, Sustainable, Urban Development, Air pollution, Planning



Abstract Book

ECHCAA/2026/023**Climate Change and Emerging Infectious Diseases: Challenges for Healthcare Systems**

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Abstract

Climate change has emerged as a major outbreak that has emerged as driver of infectious disease worldwide. Rising temperatures, altered rainfall patterns, floods, and increasing humidity result in favorable conditions for growth of pathogens, their vectors leading to spread of infectious diseases into new geographic regions. In developing countries such as India, these climatic changes have intensified seasonal outbreaks of dengue, malaria, chikungunya, and leptospirosis, particularly during the monsoon season. Similarly, tropical regions of developed countries are increasingly affected. Climatic changes such, severe flooding in northern Queensland, Australia, resulted in multiple cases of melioidosis caused by *Burkholderia pseudomallei*, an environmental bacterium that spreads through contaminated soil and floodwater, causing pneumonia, sepsis, and skin infections. Climate change is therefore not only an environmental issue but also a growing public health emergency. Weak disease surveillance systems, health inequities, disrupted data networks, and inadequate preparedness further increase vulnerability to emerging infectious diseases. Addressing these challenges requires a multidisciplinary approach involving healthcare professionals, environmental scientists, epidemiologists, and policymakers. The multidisciplinary approaches mainly consist of genomic surveillance, epidemiological evidences, biosensors for detection and analyses bare used with intercontinental and multiplatform healthcare providers. Strengthening early warning systems, environmental surveillance, public health infrastructure, and community awareness programs is essential. Furthermore, integrating artificial intelligence-based disease forecasting, satellite surveillance, genomic pathogen monitoring, and the one health approach can significantly improve early detection and outbreak prevention. Developing climate-resilient, equitable, and sustainable healthcare systems will be crucial for minimizing the future burden of climate-sensitive infectious diseases and protecting global public health.

Keywords: Climate change, Emerging infectious diseases, public health, One Health, Disease surveillance, Artificial intelligence, Flooding, Vector-borne diseases, Healthcare systems.



ECHCAA/2026/024

Sustainable Strategies & Management of Resources: Step to a Green Future

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Abstract

The world is currently having major planetary crisis of climate change, biodiversity loss, and increasing pollution. These changes are symptom of unsustainable development, is threatening the basic elements of life. Rapid industrialization, population growth, and unsustainable consumption patterns have placed immense pressure on natural resources. Sustainability refers to meeting present needs without compromising the ability of future generations to meet their own needs while maintaining environmental, social, and economic balance. Sustainable strategies such as renewable energy adoption, waste minimization, recycling, green technologies, and sustainable production practices are essential for reducing environmental degradation. Waste reduction is a major component of sustainable development, which mainly includes reusing, composting, educating various communities. Effective resource management focuses on the efficient utilization and conservation of water, energy, forests, and raw materials through responsible planning approaches. These approaches can be sustainable energy production using wind, biomass, switching to solar energy others are sustainable transport practises such as using vehicles powered by bio-CNG, electricity, or hydrogen as they reduce greenhouse gas emissions. Green technologies focus on lesser use of non-renewable sources and offer a promising alternative to traditional energy sources. It can operate in diversified areas such as bio-fuel, eco-forestry, renewable energy, and solid waste management. These measures help reduce carbon emissions, protect ecosystems, and improve resource efficiency. Furthermore, public awareness, policy support, and community participation are crucial for achieving sustainable development goals. Implementing sustainable strategies and resource management practices can help create a future that is healthier, more resilient, and greener for future generations.

Keywords: Climate Change, Resource Management, Environmental, Sustainability, green technologies.



ECHCAA/2026/025

Drought Induced Morphological Plasticity and Water Use Strategies in Vegetation

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Abstract

Mediterranean plant communities face increasing water stress due to prolonged drought events and shifting precipitation patterns associated with climate change. Present work examines the morphological and physiological adaptive responses of dominant vegetation to prolonged water deficit conditions. Field surveys conducted across five towns revealed significant within species phenotypic variation in leaf size, stomatal density, root depth, and waxy cuticle thickness among drought exposed populations. Advanced functional trait analysis demonstrates that plants subjected to repeated drought cycles exhibit reduced leaf area index by 35-45%, increased hydraulic efficiency through xylem conduit narrowing, and enhanced osmoregulatory capacity through increased solute accumulation. Species belonging to the *Quercus*, *Pinus*, and *Cistus* genera exhibited remarkable phenotypic plasticity, enabling maintenance of photosynthetic function despite soil water availability declining to 15% of field capacity. Additionally, work document significant shifts in plant reproductive strategies, with drought affected populations allocating greater biomass to root development (31% increases) and seed production at the expense of vegetative growth. Comparative analysis between plastic and non-plastic populations reveals that morphological adaptation enhances survival rates by 22-28% during severe drought periods. Root systems extended 2-3 meters deeper in drought adapted populations, accessing deeper water reserves previously unutilized. These adaptive mechanisms, while conferring short term survival advantages, may impose long term fitness costs and reduce competitive ability in mesic conditions. Findings highlight the critical importance of genetic diversity preservation and assisted migration strategies to maintain ecosystem functions under increasingly arid future climates.

Keywords: Drought adaptation, Mediterranean vegetation, Morphological plasticity, Phenotypic variation, Ecosystem resilience



ECHCAA/2026/026

Climate Driven Phenological Shifts in Temperate Forest Ecosystems

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Abstract

Climate change is fundamentally altering the phenological patterns of temperate forest vegetation, with significant implications for ecosystem functioning and biodiversity. This study synthesizes recent findings on the advancement of spring phenological events, including bud break, leaf emergence, and flowering times, which have collectively shifted earlier by 2-3 weeks over the past two decades. Through Meta analysis it has been demonstrate that earlier vegetation onset disrupts critical synchronization with animal pollinator emergence and migratory bird arrival, potentially weakening plant pollinator relationships. Species specific responses to temperature and photoperiod variations reveal differential phenological plasticity, with deciduous species showing greater adaptive capacity than evergreen conifers. Furthermore, the findings indicate that autumn phenological events remain relatively unchanged, creating temporal mismatches in resource allocation and extending the growing season by an average of 18 days. These alterations in phenological timing cascade through food webs, affecting arthropod abundance, herbivory rates, and carbon sequestration efficiency. The increased frequency of late spring frosts following early bud break has resulted in 12-30% increases in frost damage across vulnerable populations. The results underscore the urgency of incorporating phenological responses into forest management strategies and climate adaptation planning. Understanding these botanical shifts is essential for predicting ecosystem resilience and maintaining forest productivity under future climate scenarios, particularly in temperate regions experiencing rapid temperature increases.

Keywords: Phenology, Climate change, temperate forests, Growing season extension, Adaptive capacity



ECHCAA/2026/027

Eco-Friendly Drug Delivery Systems: A Sustainable Approach to Modern Pharmaceuticals

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Abstract

The pharmaceutical industry has a long history of addressing Environmental, Social, and Governance (ESG) issues due to its critical role in public health. Growing concerns regarding carbon emissions, pharmaceutical waste, plastic packaging, and improper disposal of medicines have accelerated the transition toward sustainable pharmaceutical practices. Conventional drug delivery systems (DDS) often rely on non-biodegradable materials, toxic solvents, and energy-intensive manufacturing processes, contributing to environmental pollution. Recent advances in biodegradable polymers, nanotechnology-based smart carriers, and AI-assisted personalized medicine are driving the development of greener drug delivery systems. Biodegradable polymers such as poly (lactic-co-glycolic acid) (PLGA), polycaprolactone (PCL), polylactic acid (PLA), and natural polymers including chitosan, alginate, cellulose, starch, gelatin, hyaluronic acid, dextran, and silk fibroin provide sustainable alternatives to conventional synthetic materials. These polymers degrade into non-toxic by-products, improve biocompatibility, and significantly reduce environmental burden. Emerging eco-friendly DDS such as biodegradable nanoparticles, niosomes, liposomes, microneedle patches, hydrogels, nanofibers, and 3D-printed personalized dosage forms are being developed using green synthesis approaches. Solvent-free manufacturing, supercritical fluid technology, enzyme-assisted synthesis, microbial synthesis, and continuous manufacturing further reduce waste generation, energy consumption, and carbon emissions. However, challenges including batch-to-batch variability, scale-up feasibility, cost constraints, and evolving regulatory requirements continue to limit widespread adoption. The successful implementation of sustainable drug delivery systems will require scalable low-energy production methods, robust safety frameworks, and standardized sustainability metrics. These advancements have the potential to transform modern pharmaceuticals by improving therapeutic outcomes while minimizing environmental impact.

Keywords: Eco-friendly drug delivery systems, Sustainable pharmaceuticals, green polymers, Biodegradable polymers, green synthesis, Nanotechnology, Environment.



Abstract Book

ECHCAA/2026/028**Environmental Pharmacology: An Emerging Science**

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Abstract

In order to comprehend how pharmaceutical substances affect people, animals, and ecosystems, environmental pharmacology is a new multidisciplinary field that combines pharmacology, environmental science, toxicology, and public health. A large percentage of medications and their metabolites are eliminated after delivery and find their way into the environment through wastewater, agricultural runoff, and inappropriate disposal methods. Pharmaceutical residues can linger in soil, water, and biological systems, exposing organisms to substances that are biologically active on a constant basis. The study of these compounds' environmental destiny, transformation, bioaccumulation, and toxicological consequences is the main goal of environmental pharmacology. Long-term exposure to pharmaceutical pollutants may lead to changes in biological pathways, endocrine disruption, antibiotic resistance, and ecological imbalance. The idea also relates to pharmacovigilance by extending the evaluation of medication safety beyond individual patients to encompass population-level and environmental effects, a process known as Eco pharmacovigilance. Additionally, the combination of adverse outcome pathways (AOPs) and exposome techniques offer mechanistic insights into how exposure to environmental chemicals interacts with biological systems and causes negative effects. New potential to identify environmental concerns, anticipate toxicity, and enhance sustainable drug development are provided by developments in artificial intelligence, molecular modelling, and predictive toxicology. Therefore, environmental pharmacology is an essential field for comprehending the intricate relationships that exist between medications, exposure to the environment, and biological reactions. The development of safer medications, ethical pharmaceutical management, and methods to safeguard human health and environmental sustainability are all aided by this new science.

Keywords: Adverse outcome pathways, Environmental Pharmacology, Eco pharmacovigilance, Environmental destiny



ECHCAA/2026/029

Medical Waste Management and Its Environmental Consequences: Challenges and Engineering Solutions

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Abstract

The generation and improper management of medical waste from hospitals, clinics, diagnostic laboratories, and pharmaceutical facilities constitute a significant and growing source of environmental contamination globally. Medical waste encompasses a heterogeneous mixture of infectious materials, sharps, pathological waste, pharmaceutical residues, radioactive substances, and chemical agents, each carrying distinct environmental and public health risks. As healthcare infrastructure expands worldwide in response to aging populations, rising chronic disease burdens, and successive infectious disease outbreaks, the volume of medical waste generated is escalating at an unprecedented pace, straining existing waste management capacities and threatening ecosystems in both high income and resource limited settings. Infectious medical waste, if inadequately segregated, treated, or disposed of, can introduce pathogenic microorganisms including drug resistant bacteria, viruses, and fungi into soil, surface water, and groundwater, creating reservoirs of infection that extend environmental health risks far beyond the healthcare facility perimeter. Sharps waste improperly deposited in municipal landfills or open dumps penetrates containment and directly contaminates surrounding soils and drainage channels. Chemical disinfectants, heavy metals from diagnostic equipment, and halogenated solvents used in laboratory processes contribute persistent toxic compounds to environmental matrices when released without adequate treatment. Incineration, once the default technology for medical waste treatment, is now recognized as a significant source of dioxin, furan, heavy metal, and particulate air emissions when conducted without modern pollution control equipment. The environmental legacy of uncontrolled medical waste incineration in low-income settings represents a persistent public health burden. In response, environmental engineers and healthcare administrators have developed alternative treatment technologies including autoclaving, microwave treatment, chemical disinfection, and plasma arc systems that achieve effective pathogen destruction with substantially lower air pollutant emissions and reduced carbon footprints. Advancing sustainable medical waste management requires a systems approach integrating rigorous waste segregation at the point of generation, staff training programs, investment in appropriate treatment infrastructure, and regulatory enforcement of waste management standards. Circular economy principles are beginning to penetrate healthcare including the reprocessing of single use medical devices and the recovery of precious metals from electronic medical equipment offering pathways to reduce the environmental footprint of healthcare without compromising patient safety. The medical and pharmacy sectors bear a shared responsibility to adopt waste stewardship practices commensurate with their environmental impact.

Keywords: Medical waste, Healthcare pollution, Incineration, Waste segregation, Environmental contamination



ECHCAA/2026/030

CORE MATHEMATICAL PILLARS OF ENVIRONMENTAL MODELLING

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Abstract

Environmental modelling serves as a critical bridge between theoretical science and real-world ecological decision making. At its foundation lie several core mathematical pillars that together enable scientists and policymakers to simulate, predict, and understand the behaviour of complex natural systems. Differential equations form the primary language of environmental dynamics, capturing the continuous evolution of variables such as pollutant concentrations, population densities, and atmospheric temperatures across time and space. Coupled with numerical methods including finite difference and finite element approaches these equations are rendered computationally tractable for large scale simulations. Stochastic modelling introduces probabilistic frameworks essential for quantifying uncertainty inherent in environmental data, from precipitation variability to species migration patterns. Statistical inference and Bayesian analysis further allow models to assimilate observational data, refine parameter estimates, and propagate uncertainty through predictions. Linear algebra underpins the discretisation of spatial grids and the solution of large systems of equations, while optimisation theory guides parameter calibration and scenario analysis. Systems dynamics frameworks, including compartmental and agent-based models, enable holistic representation of feedback loops and nonlinear interactions within ecosystems. Collectively, these mathematical foundations empower robust tools for climate projection, hydrological forecasting, air quality assessment, and biodiversity conservation. Advances in high performance computing and data assimilation continue to enhance the fidelity and applicability of these models, making mathematical rigour indispensable for addressing pressing environmental challenges of the twenty first century.

Keywords: Differential equations, Stochastic modelling, Numerical methods, Bayesian inference, Systems dynamics, Data assimilation



The Way to Green Pharmacy & Development of Sustainable Healthcare Solutions

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Abstract

Healthcare sector globally is facing challenges due to increasing demand, rising costs, and the need for sustainable practices. Medicines are essential for good human health but at the same time healthcare products, pharmaceuticals are responsible for 4.4% of greenhouse gas emissions globally. The APIs (Active pharmaceutical Ingredients) present in every pharmaceutical product have an important impact on environments. Their manufacturing, disposal affects both aquatic and terrestrial environment. The concentrations of APIs in surface water is usually very low, still it impacts aquatic ecosystems and drinking water resources. These APIs are in the ground water supply, the growing environment, which is a major concern for sustainable development. Currently, pharmaceutical sector is increasingly focusing on integrating environmentally responsible and sustainable practices, commonly referred to as "green pharmacy." The green pharmacy usually refers to the use of eco-friendly methods at various stages of pharmaceutical process: drug manufacturing, distribution, consumption, and disposal. Sustainable healthcare development not only focuses on environment but also on economically viable and socially equitable methods. The "GREENER" concept is used for discovery and development to reduce the environmental impact of APIs. It mainly consists of **good** practice for patients, **Reduced** off target effect, **Exposure** reduction via emission, **Environmental** biodegradable, **No** PBT (persistent, bioaccumulative as well as toxic), **Effects** reduction, **Risk** and hazard mitigation. Apart from GREENER concept sustainable drug development and manufacturing in pharmaceutical companies are exploring sustainable processes, such as using renewable energy sources, reducing the carbon footprint, and developing biodegradable or less harmful drug compounds. The pharmaceutical companies also need to implement green chemistry in manufacturing, use of renewable sources, and improvement in packaging. The eco-friendly packaging solutions need to be preferred mainly biodegradable. Pharmaceutical industry has taken initiative towards environmental sustainability, they are adopting multifaceted approaches with emphasizing on sustainable manufacturing, eco-friendly packaging, and operational efficiency. As these initiatives become more widespread, the pharmaceutical industry will achieve its goal for greener future.

Keywords: Green Pharmacy, GREENER, Sustainability, API, Biodegradable, Renewable sources



Abstract Book

ECHCAA/2026/032

The Impact of Biophilic Practices on Sustainable Hospitality: A Comprehensive Analysis of Guest Satisfaction and Hotel Performance

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Abstract

To satisfy changing guest expectations and reduce environmental effect, the hospitality sector is placing a greater emphasis on sustainability and ecologically responsible operations. The purpose of this study is to investigate visitors' views, attitudes, and behavioural intentions regarding biophilic practices at hotels. Biophilic design incorporates natural elements into the built environment by include indoor greenery, natural materials, day lighting, and access to green outside environments. These design concepts are credited with boosting human well-being, environmental quality, and generating more engaging hospitality experiences. The study investigates how visitors perceive the introduction of biophilic practices and assesses the impact on satisfaction, loyalty, and overall hotel experience. It also evaluates the larger impact of sustainability activities like as energy efficiency, trash reduction, and water conservation on visitor preferences and decision-making. Existing literature demonstrates that ecologically responsible measures not only help to preserve the environment, but also attract environmentally conscious guests and improve hotel performance. The findings shed light on the relationship between guest expectations and the present use of biophilic practices in Delhi hotels. By identifying significant trends and views, the study has practical implications for hotel managers and policymakers looking to encourage sustainable development, increase visitor happiness, and foster a more ecologically responsible and competitive hospitality industry.

Keywords: Biophilic Design, Sustainable Practices, Guest Satisfaction, Hotel Performance, Eco-Friendly, Delhi Hotels, Environmental Health, Guest Loyalty, Hospitality Industry



Abstract Book

ECHCAA/2026/033

CONSTITUTIONAL ENVIRONMENTAL RIGHTS AND THE ROLE OF COURTS IN ENVIRONMENTAL PROTECTION

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Abstract

The constitutionalizing of environmental rights represents one of the most significant legal developments of the late twentieth and early twenty-first centuries, reflecting a growing recognition that a clean, healthy, and sustainable environment is not merely a policy objective but a fundamental precondition for the exercise of human dignity and all other rights. As of the early twenty-first century, more than 150 national constitutions worldwide contain some form of environmental rights provision, ranging from procedural guarantees of access to environmental information and participation in environmental decision-making to substantive rights to a healthy environment, clean air, clean water, and a stable climate. These constitutional provisions have provided the legal foundation for a wave of environmental litigation that is reshaping the relationship between law, governance, and ecological protection. Courts at all levels from domestic constitutional tribunals to regional human rights bodies and international adjudicatory institutions are being called upon with increasing frequency to adjudicate claims that government actions or inactions violate constitutional or human rights obligations in the environmental domain. Landmark decisions such as the Netherlands Supreme Court's ruling in the Urgenda case, which upheld the Dutch government's legally binding obligation to reduce greenhouse gas emissions to protect citizens' rights to life and private life, and the Colombian Supreme Court's recognition of the Amazon as a subject of rights, signal a judicialization of environmental governance that complements and, in some cases, exceeds what legislative and executive branches have achieved. The emergent doctrine of rights of nature granting legal personhood and enforceable rights to rivers, forests, ecosystems, and other natural entities represents a jurisprudential revolution with profound implications for environmental law. Pioneered in constitutional form in Ecuador's 2008 constitution and subsequently adopted through legislation or court decisions in New Zealand, India, Colombia, and other jurisdictions, rights of nature fundamentally challenge the property-based legal paradigm that has historically treated nature as an object of human exploitation rather than a subject deserving of legal protection. Critical debates surround the limits and democratic legitimacy of judicial environmental activism. Critics argue that courts overreach when substituting judicial judgment for legislative and executive environmental policy choices. Proponents counter that constitutional rights require judicial enforcement precisely because political majorities and short-term electoral incentives systematically underweight the long-term and diffuse interests of environmental protection and future generations. Resolving this tension through carefully calibrated judicial doctrine, robust procedural rights, and genuinely participatory environmental governance remains a central challenge for constitutional environmental law in the coming decades.

Keywords: Constitutional environmental rights, Environmental litigation, Judicial activism, Rights of nature, Climate justice



ECHCAA/2026/034

Environmental Elements Influencing Drug Metabolism (CYP450)Keerti Jaswal¹, Kiran Bala^{2*}, Sidhant Sharma²

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Abstract

The cytochrome P450 (CYP450) family of enzymes is crucial for drug metabolism, toxicity, and personal drug reactions. According to recent studies, CYP450 function is greatly impacted by the exposome, which is the total of an individual's lifetime internal and external exposures. The purpose of this to examine how various exposome components, such as internal factors like gut microbiota, hormone fluctuations, and disease states, and external factors like dietary substances, lifestyle choices, and environmental pollutants, affect CYP450 expression and function, which in turn affects drug metabolism and treatment outcomes. By highlighting the molecular pathways that link these exposures to changes in drug metabolizing enzymes and their function, this illuminates the potential of personalized medicine and offers the promise of creating safer and more effective drug therapies in an increasingly dynamic exposure landscape. Recent developments in machine learning, AI and multi-omics technologies offer new techniques to investigate intricate relationships between genes, medications, biological pathways, and environmental factors. Large volumes of exposome, pharmacological, and clinical data can be analysed by AI-based algorithms to find those who are more susceptible to medication toxicity. The impact of environmental exposures on the development of adverse drug reactions (ADRs), their function in CYP450-mediated drug metabolism, and the possibility of AI-driven approaches for enhancing tailored drug safety are all highlighted in this paper. Pharmacogenomics and exposome data integration may promote safer and more efficient medication selection in precision healthcare.

Keywords: Adverse Drug Reaction, artificial intelligence, CYP540, Machine Learning



Abstract Book

ECHCAA/2026/035

ENVIRONMENTAL LIABILITY LAW AND CORPORATE ACCOUNTABILITY FOR ECOLOGICAL HARM

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Abstract

Environmental liability law constitutes one of the most powerful legal instruments available to society for deterring ecological harm, compelling the redress of damaged environments, and ensuring that the costs of pollution are borne by those responsible for causing it rather than externalized onto affected communities and taxpayers. Grounded in the foundational polluter pays principle recognized in international environmental law and embedded in the domestic legislation of most industrialized nations, environmental liability frameworks seek to align the economic incentives of corporations and individuals with the imperative of environmental protection by making ecological harm financially consequential for those who cause it. The architecture of environmental liability law varies considerably across jurisdictions but typically encompasses three overlapping legal regimes: civil liability, under which private parties and governments may seek compensation for environmental damage; administrative liability, through which regulatory agencies impose fines, penalties, and remediation orders on violators; and criminal liability, which applies to the most egregious cases of deliberate or reckless environmental harm. The United States Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) commonly known as Superfund exemplifies a strict, joint, and several liability regimes under which potentially responsible parties may be held fully accountable for cleanup costs regardless of fault or proportional contribution, a powerful if sometimes contested approach to incentivizing responsible corporate environmental behavior. Corporate environmental liability has evolved significantly in recent decades to address novel and complex challenges. The attribution of liability for diffuse, cumulative pollution such as that generated by hundreds of sources contributing to regional air quality degradation or watershed contamination requires increasingly sophisticated legal and scientific tools. Climate litigation is emerging as a frontier of environmental liability law, with plaintiffs in numerous jurisdictions pursuing claims against fossil fuel corporations and governments for climate-related damages, establishing precedents that may fundamentally reshape corporate accountability for greenhouse gas emissions. Enforcement capacity is the critical variable determining the real-world effectiveness of environmental liability law. Regulatory agencies in many developing nations and even some industrialized countries lack the resources, technical expertise, or political independence to consistently enforce environmental standards against powerful corporate actors. Strengthening enforcement institutions, expanding citizen suit provisions that enable civil society to act as private attorneys general, and developing international mechanisms for holding transnational corporations accountable for environmental harm across borders represent essential priorities for advancing the environmental protective function of liability law in a globalized economy.

Keywords: Environmental liability, corporate accountability, Polluter pays principle, Environmental damages, Regulatory enforce



Abstract Book

ECHCAA/2026/036**Green Pharmacy and Sustainable Healthcare Solutions**

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Abstract

Green pharmacy has emerged as a vital approach to promoting environmental sustainability within the healthcare sector while ensuring safe, effective, and accessible patient care. It focuses on the design, production, use, and disposal of pharmaceutical products in ways that minimize environmental impact and support public health goals. Conventional pharmaceutical practices often contribute to environmental pollution through excessive resource consumption, chemical waste generation, and the release of active pharmaceutical ingredients into water and soil ecosystems. Green pharmacy addresses these challenges by integrating environmentally responsible principles throughout the pharmaceutical lifecycle. Sustainable healthcare solutions emphasize the efficient use of resources, reduction of carbon emissions, waste management, and the adoption of eco-friendly technologies. Green pharmacy contributes to these objectives through green chemistry, biodegradable drug formulations, sustainable manufacturing processes, responsible prescribing practices, and safe medication disposal programs. These strategies help reduce ecological risks while maintaining the quality and effectiveness of healthcare services. The implementation of green pharmacy practices offers multiple benefits, including decreased environmental contamination, improved resource efficiency, lower healthcare costs, and enhanced public awareness regarding environmental stewardship. Furthermore, the integration of renewable energy sources, digital healthcare systems, and circular economy principles can strengthen the sustainability of healthcare infrastructures. Collaboration among pharmaceutical industries, healthcare professionals, policymakers, researchers, and patients is essential for achieving long-term sustainability goals. As global concerns regarding climate change, environmental degradation, and healthcare sustainability continue to grow, green pharmacy provides a practical framework for balancing human health needs with environmental protection. By promoting innovation, responsible resource management, and environmentally conscious decision-making, green pharmacy serves as a cornerstone of sustainable healthcare systems. Its adoption can contribute significantly to achieving global sustainable development objectives while safeguarding both present and future generations.

Keywords: Green Pharmacy, Sustainable Healthcare, Green Chemistry, Environmental Sustainability, Pharmaceutical Waste Management, Eco-friendly Drug Development, Circular Economy, Healthcare Innovation, Resource Efficiency, Public Health.



ECHCAA/2026/037

Biodegradable Polymers as Climate Smart Alternatives to Conventional Plastics

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Abstract

The proliferation of petroleum-based plastics has emerged as one of the most pressing environmental crises intersecting with climate change. Conventional polymers contribute significantly to greenhouse gas (GHG) emissions throughout their lifecycle from fossil fuel extraction to end-of-life incineration. This abstract examines the pivotal role of biodegradable polymers, including polylactic acid (PLA), polyhydroxyalkanoates (PHA), and starch-based composites, as sustainable alternatives in the context of a warming planet. Biodegradable polymers not only reduce dependence on fossil derived feedstocks but also lower net carbon emissions when derived from renewable biomass sources. Studies indicate that PHA production from microbial fermentation of agricultural waste can reduce GHG emissions by up to 80% compared to polyethylene. Moreover, the integration of carbon capture technologies with biopolymer manufacturing presents a dual mitigation strategy. However, challenges persist: land-use competition, water consumption, and incomplete biodegradation under ambient conditions remain barriers to large scale adoption. This abstract also evaluates lifecycle assessment (LCA) frameworks for comparing the climate footprints of bio-based versus conventional polymers. Policy recommendations, including extended producer responsibility (EPR) schemes and green procurement mandates, are discussed as enablers for transitioning to biodegradable polymer economies. The intersection of material science innovation and climate policy is shown to be critical for achieving net zero targets by 2050.

Keywords: Polylactic Acid, Polyhydroxyalkanoates, Biodegradable, Polymer, Polyethylene



ECHCAA/2026/038

Environmental Impact of Mining and Materials Engineering: Towards Circular Economy Solutions

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Abstract

The extraction and processing of raw materials through mining and materials engineering activities exert some of the most severe and long-lasting environmental impacts of any industrial sector, including extensive land disturbance, generation of acid mine drainage, heavy metal contamination of soils and waterways, dust and particulate emissions, greenhouse gas release, and the displacement of natural ecosystems. As global demand for metals and minerals intensifies driven by population growth, urbanization, and paradoxically by the materials requirements of renewable energy technologies such as lithium-ion batteries, wind turbines, and solar panels the environmental engineering of mining and materials industries faces an urgent imperative to minimize ecological harm and transition toward circular economy principles. Acid mine drainage (AMD) remains one of the most intractable environmental legacies of mining. Generated when sulfide minerals in exposed rock and tailings oxidize in contact with air and water, AMD produces highly acidic, metal laden leachate that can devastate aquatic ecosystems for decades or centuries after mine closure. Engineering solutions to AMD management include passive treatment systems such as constructed wetlands, sulfate-reducing bioreactors, and anoxic limestone drains, as well as active treatment technologies involving chemical neutralization and metal precipitation. Advances in predictive geochemical modeling and tailings management engineering are enabling more effective prevention of AMD generation at new mine sites. The circular economy paradigm offers a transformative alternative to the linear extract-use-discard model that has characterized materials engineering historically. Urban mining the recovery of metals and materials from electronic waste, construction demolition debris, and industrial byproducts is an engineering field growing rapidly in both technical sophistication and economic importance. Hydrometallurgical and pyrometallurgical processes have been refined to recover high-purity metals from complex waste streams, while engineering innovations in product design for disassembly make end of life material recovery more feasible and economical. Industrial ecology frameworks guide engineers to design manufacturing systems that mimic natural ecosystems, in which the waste of one process becomes the feedstock of another. Industrial symbiosis networks, where geographically proximate industries exchange material and energy flows, reduce virgin resource extraction and waste generation simultaneously. Life cycle assessment (LCA) tools equip engineers with the methodological capability to quantify the full environmental footprint of materials and processes, informing design decisions that genuinely reduce environmental burdens. The engineering profession must champion these circular approaches as central to responsible materials stewardship in a resource-constrained world.

Keywords: Mining engineering, Circular economy, Tailings management, Material recovery, Industrial ecology



Abstract Book

ECHCAA/2026/039

Superabsorbent Polymers in Climate Adaptive Agriculture Mitigating Drought and Food Security Risks

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Abstract

Climate change induced shifts in precipitation patterns and the intensification of drought events are severely threatening global agricultural productivity and food security. Superabsorbent polymers (SAPs), particularly cross-linked polyacrylamide and cellulose-based hydrogels, have demonstrated considerable potential as soil amendment tools to enhance water retention, reduce irrigation demand, and buffer crops against heat and drought stress. This abstract evaluates the efficacy, environmental safety, and scalability of SAP applications in climate adaptive agriculture, with emphasis on arid and semi-arid regions disproportionately affected by climate variability. SAPs can absorb water up to 500 times their own weight and release it gradually in response to soil osmotic pressure, thereby reducing crop water stress during dry spells. Field trials conducted in sub-Saharan Africa, South Asia, and the Mediterranean basin demonstrate yield improvements of 20–45% under water deficit conditions when SAPs are applied at rates of 15–30 kg/ha. The abstract also examines the environmental fate of synthetic SAPs, noting concerns regarding microplastic fragmentation, soil pH alteration, and ecotoxicological impacts on soil microbiomes. Bio-based SAP alternatives derived from modified starch, chitosan, and lignin are presented as promising climate positive substitutes with improved biodegradation profiles. Policy instruments including farmer subsidies, agricultural extension programs, and integration of SAPs within national drought adaptation strategies are discussed. The abstract argues that SAPs, when judiciously deployed, represent a cost-effective nature compatible technology for building agricultural resilience in a changing climate.

Keywords: Superabsorbent polymers, pH, Environmental, Cost, Climate



ECHCAA/2026/040

Renewable Energy Engineering and Its Role in Mitigating Greenhouse Gas Emissions

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Abstract

The engineering of renewable energy systems represents perhaps the single most consequential technical endeavor of the twenty first century in terms of its potential to mitigate anthropogenic greenhouse gas emissions and avert the most catastrophic trajectories of climate change. The combustion of fossil fuels for electricity generation, transportation, heating, and industrial processes accounts for the overwhelming majority of global carbon dioxide and methane emissions, making the transition to low carbon energy systems a fundamental environmental imperative. Renewable energy engineering spanning solar photovoltaics, wind turbine design, hydropower, geothermal systems, and energy storage technologies has advanced at remarkable speed over the past two decades, driven by sustained investment in research and development, economies of scale in manufacturing, and supportive policy frameworks in leading economies. Solar photovoltaic engineering has undergone a transformation of historic proportions. Improvements in silicon cell efficiency, the development of thin film and perovskite solar cell technologies, and innovations in module design, racking systems, and inverter electronics have reduced the levelized cost of solar electricity to levels competitive with or below fossil fuel generation in most of the world. Utility scale solar farms, rooftop distributed generation, and building-integrated photovoltaics are collectively reshaping the electricity supply landscape, displacing coal and gas generation and reducing grid wide emissions intensities. Wind energy engineering has achieved parallel breakthroughs. Modern multi megawatt turbines, incorporating advanced aerodynamic blade designs, variable speed generators, and sophisticated control systems, harvest wind resources with efficiencies unimaginable a generation ago. The expansion of offshore wind engineering is particularly significant, enabling access to stronger and more consistent wind resources near densely populated coastal areas while avoiding land use conflicts. Floating offshore wind platforms extend the exploitable wind resource to deep water sites that were previously inaccessible to fixed foundation structures. Energy storage engineering is the pivotal frontier that will enable full decarbonization of electricity systems. Lithium-ion battery technology, pumped hydro storage, compressed air energy storage, green hydrogen production through electrolysis, and emerging long duration storage technologies are being engineered to buffer the intermittency of solar and wind resources and ensure reliable grid operation. The engineering of smart grids, demand response systems, and vehicle to grid integration further optimizes renewable energy utilization. Together, these engineering advances constitute the technical backbone of the global energy transition, offering a credible pathway to deep decarbonization and the environmental stabilization it can deliver.

Keywords: Renewable energy, Greenhouse gas mitigation, Solar engineering, Wind energy, Energy transition



Abstract Book

ECHCAA/2026/041

Sustainable Life Style and Behavior Change

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Abstract

A sustainable lifestyle involves making conscious choices that minimize negative environmental impacts while promoting social well-being and economic resilience. These choices include responsible consumption, energy conservation, waste reduction, sustainable transportation, healthy dietary practices, and the efficient use of natural resources. Behavioural change plays a critical role in the successful transition toward sustainability. While technological innovations and policy interventions contribute significantly to environmental protection, long-term sustainability depends largely on changes in human attitudes, values, and daily habits. Behavioural change is influenced by a combination of psychological, social, cultural, and economic factors that shape individual decision-making processes. Education, environmental awareness, social norms, community engagement, and incentives can encourage individuals to adopt sustainable behaviours and maintain them over time. The promotion of sustainable lifestyles requires an integrated approach that combines public awareness campaigns, environmental education, supportive policies, and access to sustainable alternatives. Digital technologies and social media platforms have also emerged as effective tools for influencing behaviour, spreading environmental knowledge, and fostering collective action. Furthermore, community-based initiatives and participatory programs can strengthen individual commitment by creating a sense of responsibility and shared purpose. Adopting sustainable lifestyle practices offers numerous benefits, including reduced carbon emissions, conservation of natural resources, improved public health, and enhanced quality of life. These practices also contribute to achieving broader sustainability goals by supporting environmental protection, social equity, and economic stability. However, barriers such as lack of awareness, limited access to sustainable options, financial constraints, and resistance to change continue to hinder widespread adoption. In conclusion, sustainable lifestyles and behavioural change are interconnected elements that are essential for building a more resilient and environmentally responsible society. Encouraging positive behavioural transformations through education, policy support, and community participation can significantly contribute to sustainable development and help create a healthier future for both people and the planet.

Keywords: Sustainable Lifestyle, Behavioural Change, Environmental Sustainability, Responsible Consumption, Climate Action, Resource Conservation.



ECHCAA/2026/042

Pharmaceutical Manufacturing and Its Carbon Footprint: Pathways to a Low Carbon Medicines Industry

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Abstract

The pharmaceutical manufacturing industry, while indispensable to human health, carries a substantial and largely underappreciated environmental burden in terms of greenhouse gas emissions, energy consumption, water use, and chemical waste generation. Recent life cycle assessment studies have revealed that the pharmaceutical sector's carbon intensity measured as greenhouse gas emissions per unit of revenue exceeds that of the automotive industry, a finding that has galvanized environmental scrutiny of medicine production processes. As global pharmaceutical demand continues to grow in response to aging populations and expanding healthcare access, the industry faces an imperative to fundamentally decarbonize its operations without compromising the quality, efficacy, or affordability of the medicines on which patients depend. Pharmaceutical manufacturing is energy intensive at multiple stages, from synthesis of active pharmaceutical ingredients (APIs) through formulation, sterilization, packaging, and cold chain distribution. API synthesis in particular involves complex multi-step chemical processes utilizing large volumes of organic solvents, catalysts, and reagents under conditions of controlled temperature and pressure that demand significant energy inputs. The environmental impact is compounded by the often-low atom economy of conventional synthetic routes, wherein a large proportion of input materials ends up as chemical waste rather than incorporated into the final product molecule. Solvent waste, a major byproduct of API synthesis, represents both a greenhouse gas emission source and a hazardous waste management challenge. Green chemistry principles offer a scientifically grounded framework for reducing the carbon and environmental footprint of pharmaceutical synthesis. The twelve principles of green chemistry including atom economy, use of renewable feedstock's, catalytic rather than stoichiometric reactions, solvent reduction and substitution, and design for degradation are increasingly being applied by pharmaceutical process chemists to redesign synthetic routes that achieve the same therapeutic molecules with fewer steps, less waste, and lower energy requirements. Continuous flow chemistry, replacing batch reactors with tubular flow systems, improves reaction efficiency, safety, and energy utilization while enabling real-time process monitoring and control. Decarbonizing pharmaceutical manufacturing further requires transitioning facility energy supplies to renewable electricity and low carbon heat sources, electrifying process heating where feasible, and optimizing cold chain logistics to minimize refrigeration related emissions. Life cycle assessment provides the analytical foundation for identifying emission hotspots across the pharmaceutical value chain and prioritizing decarbonization investments accordingly. Achieving net-zero pharmaceutical manufacturing requires science-based emission targets, transparent reporting, and supply-chain collaboration to reduce carbon emissions and promote sustainability.

Keywords: Pharmaceutical manufacturing, Carbon footprint, green chemistry, Decarbonization, Life cycle assessment.



Abstract Book

ECHCAA/2026/043

Environmental Marketing Management: Consumer Behavior, Green Branding, and Sustainable Market Transformation

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Abstract

Marketing management occupies a uniquely influential position in the relationship between business and environmental change, wielding the power to shape consumer values, normalize sustainable behaviors, drive demand for environmentally superior products, and accelerate the market diffusion of green innovations. The evolution of environmental marketing from a niche specialty into a mainstream strategic imperative reflects both the growing environmental consciousness of consumers across demographic groups and the increasing recognition by marketing professionals that sustainability authenticity is a decisive factor in brand equity, consumer loyalty, and long-term market positioning. Understanding how marketing management can catalyze genuine environmental transformation rather than merely serving as a vehicle for green washing is among the most important challenges facing contemporary business education and practice. Consumer behavior research has illuminated the complex psychological, social, and situational factors that influence environmentally significant purchasing decisions. The attitude behavior gaps the well documented discrepancy between consumers expressed environmental values and their actual purchasing choices remains a central puzzle for environmental marketing managers. Behavioral economics insights, including the power of defaults, social norms, loss framing, and convenience in shaping behavior, have been productively applied to the design of sustainable product offerings, retail environments, and digital marketing experiences that make the environmentally preferable choice the easy choice. Segmentation strategies based on environmental values, knowledge, and behavior enable marketers to tailor communications and product propositions to distinct consumer groups with different motivational profiles. Green branding and environmental communication carry both opportunity and risk for management teams. Brands that credibly demonstrate environmental commitments backed by verifiable performance data, third-party certifications, transparent supply chain disclosure, and genuine product innovation can command price premiums, build deep consumer loyalty, and attract talent aligned with organizational values. Conversely, green washing the practice of making misleading or unsubstantiated environmental claims has become a significant regulatory and reputational liability as regulators in the European Union, United States, and other jurisdictions introduce stricter standards for environmental marketing claims. At the macro marketing level, marketing management has the potential to contribute to systemic market transformation by shifting the social and cultural contexts in which consumption decisions are made. Campaigns that normalize sustainable lifestyles, challenge consumption norms, champion product longevity over planned obsolescence, and reframe the meaning of value beyond material acquisition can contribute to the deeper cultural shifts necessary for sustainable consumption patterns. Management education must equip future marketing leaders with both the technical toolkit and the ethical compass to deploy marketing's considerable power in service of environmental as well as commercial goals.

Keywords: Green marketing, Consumer behavior, Sustainable branding, Environmental communication, Market transformation.



Abstract Book

ECHCAA/2026/044

Supply Chain Management and Environmental Sustainability: Greening Global Value Chains

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Abstract

Global supply chains are among the most powerful levers through which corporate management decisions translate into environmental outcomes at planetary scale. The decisions made by supply chain managers regarding sourcing, logistics, manufacturing processes, packaging, and end of life product management collectively determine a substantial portion of the environmental footprint associated with goods and services consumed worldwide. As pressure from regulators, institutional investors, civil society organizations, and environmentally conscious consumers intensifies, supply chain management has evolved from a function primarily concerned with cost minimization and delivery reliability into a strategic domain in which environmental performance is a central dimension of operational excellence and corporate reputation. Green supply chain management (GSCM) encompasses the integration of environmental considerations into procurement decisions, supplier selection and development, manufacturing process design, logistics optimization, and reverse logistics for product recovery and recycling. From a management perspective, implementing GSCM requires overcoming significant organizational and inter organizational challenges: aligning incentives across complex multi-tier supplier networks, developing robust environmental performance metrics and supplier audit capabilities, managing the cost implications of environmental upgrades, and building the internal capabilities needed to analyze and reduce supply chain carbon footprints. Carbon footprint measurement and management across supply chains encompassing Scope 1, 2, and 3 greenhouse gas emissions has become a core competency demanded of supply chain managers. Scope 3 emissions, which include all indirect emissions occurring in a company's value chain upstream and downstream of its own operations, typically account for the majority of a large corporation's total climate impact, yet they are the most complex to measure, manage, and reduce. Advanced supply chain management programs now train students in life cycle assessment methodologies, carbon accounting standards, and supplier engagement strategies that can drive emissions reductions across entire value chains. Circular supply chain design represents the frontier of sustainable supply chain management. By engineering supply chains to recover, refurbish, remanufacture, and recycle materials at end of product life, management can dramatically reduce resource consumption and waste generation while creating new revenue streams from secondary materials markets. Digital technologies including block chain for supply chain transparency, IoT for real time environmental monitoring, and artificial intelligence for logistics optimization are equipping supply chain managers with unprecedented visibility and control over the environmental performance of their global operations, making genuine sustainability transformation achievable at scale.

Keywords: Green supply chain, Environmental sustainability, Carbon footprint, Supplier engagement, Circular supply chains



ECHCAA/2026/045

Role of Clinical Medicine in Promoting Planetary Health: Integrating Environmental Awareness into Healthcare Practice

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Abstract

The concept of planetary health defined as the health of human civilization and the natural systems that sustain it demands a fundamental reconceptualization of the role of clinical medicine in addressing environmental change. Physicians, nurses, pharmacists, and allied health professionals have historically defined their professional mandate in terms of individual patient care, yet mounting evidence demonstrates that environmental degradation, climate change, biodiversity loss, and ecosystem disruption are major determinants of population health outcomes, driving increases in infectious disease, respiratory illness, heat related mortality, malnutrition, mental health disorders, and displacement related trauma. The healthcare community thus occupies a uniquely credible position from which to advocate for environmental protection as an act of preventive medicine at the societal scale. Clinical medicine's intersection with environmental change begins with the direct health consequences that practitioners observe and treat daily. Physicians in emergency departments manage escalating presentations of heat stroke and dehydration during more frequent and intense heat waves. Pulmonologists treat patients with worsening asthma and chronic obstructive pulmonary disease in cities where wildfire smoke now seasonally blankets previously clean air regions. Infectious disease specialists confront the expanding geographic ranges of vector borne diseases such as dengue, malaria, and Lyme disease as warming temperatures shift the ecological boundaries of their arthropod vectors. Pediatricians document rising rates of developmental disorders linked to environmental chemical exposures. These clinical realities anchor environmental advocacy in empirical patient experience rather than abstract environmental concern. Medical education is increasingly incorporating planetary health and environmental medicine to prepare clinicians to identify environmentally related diseases, counsel patients, and support evidence-based health policies. Medical organizations worldwide recognize climate change as a major public health threat. As healthcare contributes significantly to global emissions, sustainable practices such as energy efficient hospitals, reduced waste, and telemedicine are essential. Integrating planetary health into clinical practice is crucial for protecting public health and promoting sustainable healthcare.

Keywords: Planetary health, Clinical medicine, Physician advocacy, Environmental health literacy, Sustainable healthcare



ECHCAA/2026/046

Drug Disposal, Pharmaceutical Take Back Programs, and Community Pharmacy's Role in Environmental Stewardship

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Abstract

The improper disposal of unused, expired, and unwanted medications by patients and caregivers constitutes a pervasive yet largely invisible source of pharmaceutical contamination of water and soil environments. Surveys consistently demonstrate that substantial proportions of the public dispose of medications by flushing them down toilets, pouring liquid preparations down drains, or depositing them in household waste destined for landfill all pathways that introduce biologically active pharmaceutical compounds into environmental matrices where they can persist, accumulate, and exert adverse effects on aquatic organisms, terrestrial ecosystems, and potentially on humans through contaminated drinking water. Community pharmacies, as the most accessible and trusted healthcare touch points for the general public, occupy a pivotal position in transforming medication disposal behaviors and championing pharmaceutical environmental stewardship at the community level. Pharmaceutical take back programs, through which patients return unused medications to pharmacies or designated collection sites for safe disposal, represent the most effective currently available mechanism for intercepting medication waste before it reaches environmental receptors. Evidence from program evaluations in Europe, North America, and Australia demonstrates that accessible, well publicized take back services substantially increase the proportion of unused medications collected through safe channels, reduce rates of environmental disposal, and simultaneously decrease risks of accidental pediatric ingestion and medication diversion. Pharmacist counseling at the point of dispensing providing patients with clear, consistent messaging about the environmental and safety risks of improper disposal and directing them to take back facilities is associated with significantly improved disposal behaviors. The regulatory and logistical frameworks governing pharmaceutical take back vary considerably across jurisdictions. Extended Producer Responsibility (EPR) programs make pharmaceutical manufacturers responsible for managing medication waste and have successfully supported drug take-back systems in several countries. Community pharmacies also contribute to environmental sustainability through medication therapy management, reducing unnecessary prescribing, minimizing waste, improving adherence, and supporting deprescribing initiatives. Embedding environmental stewardship into pharmacy education and practice standards can strengthen the role of pharmacies in protecting both public and environmental health.

Keywords: Drug disposal, pharmaceutical take back, Community pharmacy, Environmental stewardship, Medication waste



ECHCAA/2026/047

Environmental Determinants of Disease: How Ecological Degradation Is Reshaping the Global Burden of Illness

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Abstract

The global burden of disease is undergoing a profound transformation driven not solely by demographic aging, behavioral risk factors, or genetic predisposition, but increasingly by the degradation of the natural environments on which human health ultimately depends. Environmental epidemiology the discipline that investigates the relationships between environmental exposures and disease incidence, distribution, and outcomes has accumulated compelling evidence that ecological changes, including deforestation, biodiversity loss, soil degradation, air and water pollution, and climate disruption, are reshaping patterns of infectious and non-communicable disease in ways that existing medical and public health systems are poorly prepared to address. Understanding and responding to these environmental determinants of disease is now a central challenge for medicine and pharmacy in the twenty first century. Deforestation and habitat fragmentation represent major drivers of emerging infectious disease, facilitating increased contact between humans, domesticated animals, and wildlife reservoirs of zoonotic pathogens. The ecological disruption of forest clearance compresses previously buffered interfaces between humans and wildlife, creating conditions permissive to viral spillover events the transmission of pathogens from animal reservoirs to human populations that have seeded outbreaks of Ebola, Nipah virus, and novel corona viruses. Biodiversity loss further amplifies disease transmission risk through the dilution effect: in intact ecosystems, pathogen transmission is naturally buffered by the presence of incompetent host species that absorb infectious bites from vectors without amplifying pathogen populations. As biodiversity erodes, competent reservoir hosts dominate, intensifying transmission. Air pollution, generated primarily by fossil fuel combustion, industrial processes, and agricultural burning, is now recognized as the world's largest environmental health risk factor, responsible for an estimated seven million premature deaths annually. Fine particulate matter (PM_{2.5}) penetrates deep into pulmonary tissue, triggering inflammatory cascades that drive cardiovascular disease, stroke, lung cancer, and chronic obstructive pulmonary disease. Environmental medicine and pharmacology are revealing how air pollution alters immune function, worsens allergic diseases, and can reduce the effectiveness of certain medications. The pharmacy profession addresses these challenges through antimicrobial stewardship, development of therapies for emerging environmental diseases, and monitoring drug–environment interactions. Strengthening healthcare responses to ecological change requires integrating environmental science into clinical education, research, and policy, recognizing the close connection between ecosystem and human health.

Keywords: Environmental determinants, Disease burden, Ecological degradation, Vector-borne disease, Environmental epidemiology.



Abstract Book

ECHCAA/2026/048

Manufacturing Emissions and Carbon Footprint of Global Pharmaceutical Industry

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Abstract

The global pharmaceutical industry contributes significantly to climate change through its manufacturing processes and operational emissions. This study examines the carbon footprint of major pharmaceutical corporations and their role in accelerating climate change. We analyzed emissions data from over 50 multinational pharmaceutical companies, revealing that the industry generates approximately 52 million metric tons of CO₂ equivalents annually equivalent to the emissions of 11 million cars. Manufacturing facilities account for 40% of direct emissions, while supply chain activities contribute 60%. The study identified critical hotspots in drug synthesis, sterilization processes, and chemical intermediary production. Active pharmaceutical ingredients (APIs) production in high emission jurisdictions exacerbates the problem. We found that companies utilizing renewable energy in manufacturing plants reduced their carbon intensity by 35-45%. The research highlights that without significant technological intervention and regulatory enforcement, pharmaceutical manufacturing will become an increasingly prominent contributor to global greenhouse gas emissions. Recommendations include transitioning to green chemistry principles, implementing carbon pricing mechanisms, and establishing mandatory sustainability reporting standards. The findings underscore the urgency for the pharmaceutical sector to align with Paris Agreement targets and demonstrate corporate responsibility in climate mitigation efforts.

Keywords: Pharmaceutical manufacturing, Carbon footprint, Greenhouse gas emissions, Climate change, API production, green chemistry



Abstract Book

ECHCAA/2026/049

Water Contamination and Aquatic Ecosystem Degradation from Pharmaceutical Discharge

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Abstract

Pharmaceutical compounds contaminating freshwater and marine ecosystems represent an emerging environmental health crisis. This comprehensive review examines how pharmaceutical manufacturing, wastewater discharge, and improper medication disposal contribute to widespread aquatic contamination. Residual active pharmaceutical ingredients including antibiotics, hormones, and antidepressants persist in water systems despite conventional treatment processes. We surveyed 150 water bodies across multiple continents, detecting pharmaceutical residues in 94% of sampled locations at concentrations ranging from nanograms to micrograms per liter. The study documents ecological consequences including feminization of male fish populations, altered predator prey dynamics, and antibiotic-resistant bacteria proliferation in aquatic environments. Pharmaceutical manufacturing facilities in developing nations discharge inadequately treated wastewater containing hazardous chemicals and heavy metals, exacerbating contamination. Our research reveals that treatment plant upgrades could eliminate 70-80% of pharmaceutical residues at relatively modest costs (0.2-0.5% of municipal budgets). Climate change exacerbates this problem through altered precipitation patterns affecting water flow and chemical concentration. The study emphasizes that climate warming reduces freshwater availability, increasing pharmaceutical compound concentrations through dilution effects. Recommendations include implementing advanced treatment technologies (activated carbon, ozonation and UV irradiation), establishing pharmaceutical take back programs, and regulating industrial discharge standards. This research underscores the interconnection between climate change, water security, and pharmaceutical pollution, advocating for integrated environmental management strategies addressing all three dimensions simultaneously.

Keywords: Pharmaceutical contamination, Water pollution, Aquatic ecosystems, Antibiotic resistance, Waste water treatment, Climate resilience



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Antibiotic Resistance and the Environmental Pharmaceutical Burden: A One Health Perspective

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Abstract

The global crisis of antimicrobial resistance (AMR) is inextricably linked to the widespread environmental dissemination of antibiotic pharmaceuticals. Each year, millions of tons of antibiotics are consumed by humans and livestock for therapeutic, prophylactic, and growth-promotion purposes. A substantial fraction of these compounds is excreted unchanged or as bioactive metabolites, entering soil and water environments through agricultural runoff, sewage effluents, and solid waste disposal. This environmental contamination creates persistent selective pressure on microbial communities, accelerating the emergence, evolution, and spread of antibiotic-resistant organisms and resistance genes collectively termed the environmental resistome. The One Health framework, which recognizes the interconnectedness of human, animal, and environmental health, provides a critical lens through which to understand this challenge. Resistance genes originating in environmental bacteria can be transferred horizontally to human pathogens through mobile genetic elements such as plasmids, transposons, and integrins. Agricultural soils receiving manure from antibiotic-treated livestock have been shown to harbor elevated concentrations of resistance genes, which can subsequently migrate into groundwater and food crops, completing a circuit of resistance dissemination that ultimately threatens clinical treatment outcomes. Pharmaceutical manufacturing effluents represent a particularly concentrated source of antibiotic contamination. Studies of waterways near antibiotic production facilities in Asia and elsewhere have documented antibiotic concentrations orders of magnitude above minimum inhibitory concentrations, creating hotspots of resistance selection. Wastewater treatment plants, while effective at removing many contaminants, show limited efficacy against some antibiotic compounds and may themselves act as reactors for resistance gene exchange. Addressing this crisis demands coordinated action across human medicine, veterinary practice, agriculture, pharmaceutical regulation, and environmental management. Strategies must include the rational use of antibiotics, investment in wastewater treatment upgrades, environmental monitoring programs, stricter discharge standards for pharmaceutical facilities, and global surveillance of resistance trends. Without integrated intervention grounded in the One Health approach, the environmental pharmaceutical burden will continue to erode the foundational pillar of modern infectious disease management.

Keywords: Antibiotic resistance, One Health, Antimicrobial contamination, Environmental resistome, Horizontal gene transfer



Abstract Book

ECHCAA/2026/051**Biodiversity Conservation and Net Zero Strategies for Effective Climate Action**

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Abstract

In order to effectively address the growing environmental issue, biodiversity conservation and net zero initiatives are essential components of climate action. Because it provides vital functions including carbon sequestration, soil fertility, water regulation, and climate moderation, biodiversity is the foundation of ecosystem stability. However, environmental deterioration and species decrease are being accelerated by pollution, habitat loss, and climate change. In order to control the rise in global temperatures, net zero strategies which balance greenhouse gas emissions with removals are essential. Afforestation, reforestation, increasing energy efficiency, switching to renewable energy, and encouraging sustainable land use practices are some of these tactics. Long-term carbon storage is supported and ecosystem resilience is increased when biodiversity conservation is integrated with net zero approaches. Wetland restoration and forest conservation are two examples of nature-based solutions that provide both climate adaptation and mitigation. Coordinated policies are necessary for effective climate action. scientific advancement and community involvement. Achieving sustainable development and guaranteeing ecological and human well-being requires a comprehensive strategy that links biodiversity preservation with net zero commitments.

Key words: Biodiversity, Net zero emissions, Climate action, Ecosystem resilience, Carbon sequestration, Renewable energy, Sustainable development



Abstract Book

ECHCAA/2026/052

Economical Relevance of Environment and Climate Change

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Abstract

Climate change and environmental degradation present unprecedented economic challenges and opportunities in the 21st century. The interconnection between environmental systems and economic performance has become increasingly critical as global temperatures rise, ecosystems deteriorate, and resource scarcity intensifies. This abstract examines the multifaceted economic implications of environmental degradation and climate change on global markets, supply chains, and long-term economic stability. The economic costs of climate change are staggering and multidimensional. Natural disasters, altered agricultural productivity, rising sea levels, and resource depletion impose substantial direct costs on industries and governments worldwide. The World Bank estimates that climate change could reduce global GDP by 10-23% by 2100 without mitigation efforts. Additionally, environmental externalities such as pollution and carbon emissions are inadequately priced in conventional economic models, leading to market failures and inefficient resource allocation. Simultaneously, the transition toward sustainable economies creates new economic opportunities. Renewable energy sectors, green technologies, and circular economy models are generating substantial employment and investment opportunities. Countries investing in environmental sustainability demonstrate enhanced resilience and competitive advantages in emerging global markets. However, this transition requires significant capital reallocation and structural economic reorganization. The integration of environmental considerations into economic policy, corporate strategy, and investment decisions is imperative. Carbon pricing, environmental regulations, and sustainable finance mechanisms are essential instruments for internalizing environmental costs and redirecting capital flows toward sustainable development. Furthermore, nature-based solutions and ecosystem services offer cost effective approaches to addressing both climate mitigation and economic development. Understanding the profound economic relevance of environmental and climate issues is crucial for policymakers, investors, and businesses seeking to navigate the complexities of a climate constrained world while maintaining economic prosperity and social welfare.

Keywords: Climate Change Economics, Environmental Degradation, Carbon Pricing, Sustainable Development, Green Economy, Economic Externalities

**Economic Costs and Opportunities of Climate Change Mitigation**

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Abstract

Climate change poses unprecedented economic challenges and opportunities for global markets. The economic relevance of climate action extends beyond environmental preservation to encompass GDP impacts, labor market transformation, and investment reallocation across sectors. Rising temperatures increase costs associated with extreme weather events, agricultural productivity losses, and infrastructure degradation, estimated at trillions of dollars globally by mid-century. Conversely, transitioning to renewable energy and sustainable practices creates substantial economic opportunities through job creation, technological innovation, and new market development. The cost of inaction significantly exceeds investment in mitigation and adaptation strategies, as delayed climate action amplifies economic vulnerability and magnifies long-term fiscal burdens on governments and businesses. However, the economic transition presents distributional challenges, requiring careful policy design to manage disruptions in carbon dependent industries while supporting workforce retraining and regional economic diversification. Financial markets increasingly incorporate climate related risk assessment, affecting capital allocation and asset valuations. Carbon pricing mechanisms, green bonds, and sustainable finance instruments emerge as crucial tools for redirecting investment toward climate-resilient infrastructure and low carbon technologies. The economic case for climate action strengthens as renewable energy costs decline and economies of scale improve. Integrating climate considerations into macroeconomic policy, fiscal planning, and corporate strategy becomes essential for long-term economic stability and competitiveness. This transition demands coordinated international efforts, technological partnerships, and substantial public and private investment to achieve both climate goals and sustainable economic growth.

Keywords: Climate change mitigation, Economic transition, Renewable energy, Carbon pricing, Sustainable finance, Economic resilience



Abstract Book

ECHCAA/2026/054

Pharmaceutical Pollutants in Aquatic Ecosystems: Sources, Fate, and Ecological Consequences

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Abstract

The proliferation of pharmaceutical compounds in aquatic ecosystems has emerged as one of the most pressing environmental challenges of the twenty first century. Pharmaceuticals enter water bodies through multiple pathways, including incomplete metabolism and excretion by humans and animals, improper disposal of unused medications, and effluent discharge from hospitals, pharmaceutical manufacturing facilities, and municipal wastewater treatment plants. Unlike conventional pollutants, pharmaceutical compounds are specifically designed to exert biological activity at low concentrations, rendering them uniquely hazardous to non-target aquatic organisms even at trace levels detected in the range of nanograms to micrograms per liter. Once introduced into aquatic environments, pharmaceuticals undergo complex transformation processes influenced by photolysis, hydrolysis, biodegradation, and sorption onto sediments. However, many active pharmaceutical ingredients (APIs) exhibit remarkable persistence, resisting conventional wastewater treatment processes and accumulating in surface waters, groundwater, and even marine environments. Compounds such as synthetic estrogens (notably 17 α -ethinylestradiol), non-steroidal anti-inflammatory drugs (NSAIDs), antibiotics, and antidepressants have been detected globally in rivers, lakes, coastal waters, and drinking water supplies. Ecological consequences are wide-ranging and multifaceted. Endocrine disrupting pharmaceuticals have been conclusively linked to feminization of male fish populations, reproductive failure, and population level declines in freshwater fish. Antibiotic residues contribute to the selection and propagation of antibiotic-resistant bacteria and resistance genes in aquatic microbial communities, posing a serious threat to both ecosystem function and public health. Psychoactive drugs such as selective serotonin reuptake inhibitors (SSRIs) alter the behavioral patterns of aquatic invertebrates and fish, disrupting predator prey dynamics and ecosystem stability. This abstract reviews the current state of knowledge regarding pharmaceutical contamination of aquatic systems, emphasizing the need for advanced treatment technologies, robust environmental risk assessment frameworks, and international regulatory cooperation to mitigate the growing burden of pharmaceutical pollution on aquatic biodiversity and ecosystem services.

Keywords: Pharmaceutical pollutants, Aquatic toxicology, Endocrine disruption, Emerging contaminants, Ecotoxicology.



Abstract Book

ECHCAA/2026/055

Pharmaceutical Residues in Agricultural Soils: Bioaccumulation, Phytotoxicity, and Food Safety Implications

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Abstract

Agricultural soils have become significant repositories of pharmaceutical compounds, primarily through the application of biosolids (sewage sludge), veterinary drug contaminated manure, and irrigation with reclaimed wastewater. The accumulation of pharmaceuticals in soils poses complex risks to terrestrial ecosystems, agricultural productivity, and ultimately to human health through the food chain. Unlike aquatic environments, soil matrices present unique physicochemical conditions varying pH, organic matter content, microbial diversity, and clay mineralogy that profoundly influence the adsorption, transformation, and bioavailability of pharmaceutical residues. A broad spectrum of pharmaceutical classes has been detected in agricultural soils worldwide, including tetracyclines, fluoroquinolones, sulfonamides, hormones, analgesics, and psychiatric medications. These compounds can persist in soils for months to years, depending on their physicochemical properties and local environmental conditions. The interaction between pharmaceuticals and soil microbiota is particularly consequential: sub-inhibitory antibiotic concentrations in soil drive the selection of resistant microbial populations, alter microbial community structure and function, and impair critical ecosystem services such as nutrient cycling, organic matter decomposition, and nitrogen fixation. Phytotoxicity represents another dimension of the agricultural pharmaceutical problem. Numerous studies have demonstrated that pharmaceutical residues in soil can inhibit seed germination, reduce root elongation, diminish photosynthetic efficiency, and alter plant metabolic pathways in various crop species. More concerningly, plants actively take up certain pharmaceuticals through their roots, leading to accumulation in edible tissues including leaves, fruits, and tubers thereby introducing pharmaceutical residues directly into the human diet and challenging food safety assurance systems. Addressing pharmaceutical contamination of agricultural soils requires a multi-pronged approach: improving sewage sludge treatment standards, regulating veterinary pharmaceutical use, developing remediation technologies such as phytoremediation and advanced composting, and establishing maximum residue limits for pharmaceuticals in food crops. Strengthening monitoring programs and risk assessment frameworks will be essential to protecting soil ecosystem integrity and ensuring the safety of food produced on pharmaceutical contaminated land.

Keywords: Pharmaceutical residues, Soil contamination, Phytotoxicity, Bioaccumulation, Food safety



Abstract Book

ECHCAA/2026/056**Carbon Management, Net-Zero Strategies and Climate Action**

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Abstract

Climate change is one of the most significant global challenges of the twenty-first century, driven primarily by the increasing concentration of greenhouse gases (GHGs) in the atmosphere. Carbon management and net-zero strategies have emerged as critical approaches for mitigating climate change and achieving sustainable development. Carbon management refers to the systematic measurement, reduction, capture, utilization, and storage of carbon emissions generated from industrial, transportation, agricultural, and energy-related activities. Achieving net zero requires a combination of deep emission reductions, energy efficiency improvements, renewable energy adoption, and carbon removal technologies. Key strategies include transitioning from fossil fuels to clean energy sources such as solar, wind, and hydropower; promoting sustainable transportation through electric vehicles and public transit systems; enhancing industrial efficiency; and implementing circular economy practices that reduce waste and resource consumption. Additionally, nature-based solutions such as afforestation, reforestation, and ecosystem restoration play a vital role in enhancing carbon sequestration and supporting biodiversity conservation. Technological innovations are equally important in carbon management. Carbon Capture, Utilization, and Storage (CCUS) technologies can capture carbon dioxide emissions from industrial facilities and power plants, preventing their release into the atmosphere. Emerging technologies such as Direct Air Capture (DAC) and green hydrogen production further contribute to long-term decarbonization efforts. Climate action requires the active participation of governments, industries, academic institutions, and communities. Furthermore, public awareness, sustainable consumption patterns, and behavioral changes are crucial for reducing emissions at the individual level. By integrating technological innovation, policy interventions, renewable energy deployment, and ecosystem-based solutions, societies can significantly reduce greenhouse gas emissions and build resilient, sustainable economies. Accelerated climate action is essential to limit global warming, protect ecosystems, and ensure a healthier and more sustainable future for present and future generations.

Keywords: CCUS- Carbon Capture, Utilization, and Storage, DAC-Direct Air Capture



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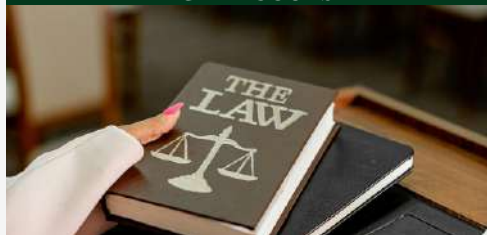


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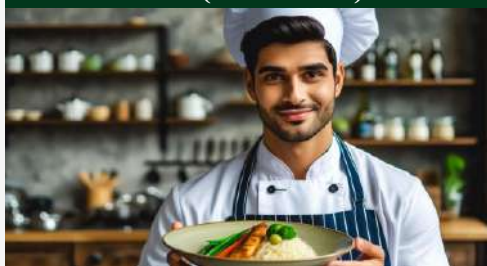
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