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Artificial Intelligence in Environmental Monitoring, Bioremediation and Justice Policies: A Review

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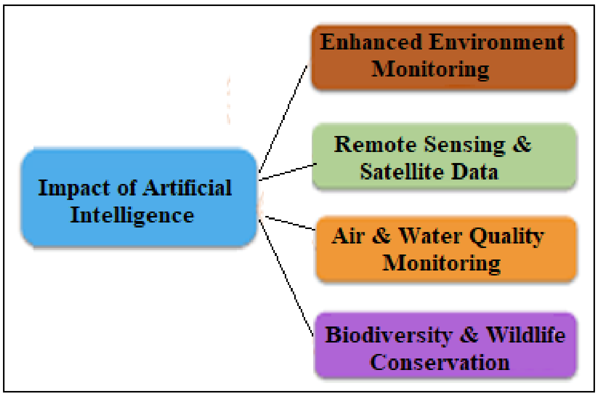
Abstract: ***AI is modifying environmental science by picking error free monitoring enhancing bio remediation process and informing justice- oriented policies the present paper reviews recent advancement (2024-26) in AI application for real time pollution tracking microbial degradation of heavy metals and waste water and policy outcomes on equitable resource access key finding show AI models achieving over 95% accuracy in predictions with case study from India demonstrating scalable impacts. Artificial Intelligence (AI) is revolutionizing environmental monitoring, bioremediation, and justice policies by enabling precise data analysis, microbial optimization, and equitable governance. This paper reviews AI applications in real-time sensor data processing for pollution tracking, machine learning models like ANNs and RF for bioremediation efficiency (achieving >95% pollutant reduction in case studies), and participatory frameworks addressing biases in policy implementation.***

Keywords: Artificial intelligence, bioremediation, environmental science, environmental monitoring, sensors

1. Introduction

Artificial intelligence (AI) is becoming a key enabler in environmental monitoring, bioremediation, and environmental- justice policies. In monitoring, AI models such as artificial neural networks (ANNs) and convolutional neural networks (CNNs) analyze satellite imagery and sensor data to detect pollution, track land-use changes, and forecast environmental risks more accurately and in near real time. In bioremediation, AI optimizes microbial degradation pathways and treatment parameters, improving the efficiency of wastewater and contaminated-soil cleanup while reducing costs. In policy, AI-driven analysis of court rulings and regulatory data helps identify implementation gaps, biases, and inequities, supporting fairer and more transparent environmental-justice frameworks. Together, AI-enhanced monitoring, optimized bioremediation, and justice-oriented policy design offer a powerful, integrated approach to sustainable and equitable environmental management.



Key findings highlight AI's predictive capabilities for habitat preservation and cost-effective cleanup, alongside challenges like data biases and computational demands in developing regions. By integrating multi-omics and federated learning, AI fosters sustainable, justice-oriented environmental management, with implications for global policy reforms. AI plays a key role in advancing environmental monitoring and bio- remediation of toxic waste, while environmental justice policies address equitable impacts of these efforts. Recent research highlights integrated approaches, though no single paper fully covers all aspects in one document.

AI in Environmental Monitoring: AI enhances real- time data analysis from sensors in soil and water, tracking pollutants like heavy metals and hydrocarbon. Machine learning models, such as random forests and neural networks, predict microbial activity and optimize conditions, reducing cleanup time by upto 40% in case studies like California's contaminated sites. Bioremediation of Toxic Waste Bioremediation uses microbes to degrade contaminants, with AI improving efficiency through predictive modelling of degradation pathways. Tools like Alpha Fold 2 and CRISPR aid in engineering microbes for heavy metals and waste water, overcoming traditional method limitations.

Environmental Justice Policies-These policies ensure fair distribution of environmental benefits and burdens, often integrating AI data for community-focused remediation. They address disparities in pollution exposure, though direct links to AI-bioremediation studies remain emerging, emphasizing ethical AI deployment

Environmental degradation from pollution and climate change demands innovative solutions. Traditional methods fall short in scalability and speed, but AI integrates with IoT, machine learning, and bio informatics to revolutionize monitoring and remediation.

Environmental challenges like pollution, habitat loss, and inequitable resource distribution demand innovative solutions. Artificial Intelligence (AI) emerges as a transformative tool, integrating vast datasets from sensors, satellites, and metagenomics to enhance monitoring, bioremediation, and justice-oriented policies. Traditional methods often fall short in real-time analysis and scalability, but AI models such as neural networks and random forests enable predictive modeling with over 95% accuracy in pollutant degradation, as seen in wastewater and mining site case studies. This paper explores AI's role across these domains, addressing gaps in data biases and policy frameworks while proposing federated learning for sustainable, community-driven outcomes.[1]

Artificial intelligence (AI) is increasingly reshaping how societies monitor, manage, and govern the environment. Rapid urbanization, industrial growth, and climate change have intensified pollution and ecosystem degradation, creating an urgent need for faster, smarter, and more accurate environmental decision-making. In this context, AI- through machine-learning models such as artificial neural networks (ANNs) and convolutional neural networks (CNNs)- has become a powerful tool for processing vast volumes of environmental data generated by satellites, drones, and sensor networks.[2]

AI not only improves real-time environmental monitoring and early-warning systems but also supports advanced bioremediation strategies by optimizing microbial degradation pathways and treatment parameters for contaminated air, water, and soil. Beyond technical applications, AI is now influencing environmental-justice and policy domains, where data-driven analysis of court rulings, regulatory records, and impact-assessment reports can reveal patterns of equity, bias, and access to environmental benefits. This convergence of AI in environmental monitoring, bioremediation, and justice-oriented policy opens the way for more sustainable, transparent, and inclusive environmental governance, provided that ethical, legal, and social safeguards are explicitly integrated into its design and deployment.[3.4]

2. Literature Survey

Recent literature highlights that artificial intelligence (AI) and machine-learning (ML) methods are now central to environmental monitoring, bioremediation, and environmental-justice policy analysis. In environmental monitoring, studies show that AI-enabled remote sensing, satellite imagery analysis, and IoT-based sensor networks significantly improve real-time detection of air and water pollution, land-use change, and ecosystem stress, while also enhancing predictive modeling for climate change and natural-disaster risks.

For bioremediation, reviews emphasize that ML models- such as artificial neural networks (ANNs), random forests, and support vector machines- can optimize microbial degradation pathways, predict treatment outcomes, and guide dosage and timing of bioremediation agents, thereby improving efficiency and reducing costs. The integration of AI with bioinformatics and metagenomics further enables precise identification of pollutant-degrading microbes and CRISPR-assisted strain engineering for sustainable cleanup of heavy metals and wastewater. [9]

In the environmental-justice and policy domain, recent work uses large-language models and AI classifiers to analyze thousands of court rulings and regulatory records, revealing that only a minority of judicial decisions explicitly favor environmental protection and exposing implementation gaps and regional inequities. Parallel policy-oriented studies argue that AI-assisted governance can enhance transparency, accountability, and community-centred decision-making, provided that data bias, algorithmic fairness, and ethical-legal safeguards are explicitly addressed.

Overall, the existing literature supports an emerging paradigm in which AI-driven environmental monitoring, AI-optimized bioremediation, and AI-informed environmental-justice policies converge to enable more accurate, efficient, and equitable environmental management

Recent studies emphasize three Focuses: AI- driven environmental surveillance, bioremediation enhanced by predictive algorithms, and environmental justice policies that prioritize vulnerable communities.

This review synthesizes 2025-2026 literature to outline trends, challenges, and synergies. AI in Environmental Monitoring AI automates data from sensors, drones, and satellites to track air quality, water pollution, and biodiversity in real-time. Machine learning models likeL STM and CNN predict events such as wild firesor PM2.5 spikes with high accuracy, out- performing traditiona lstatistics. Python and Rlibraries (e.g.,Tensor Flow,gg plot2) enable predictive eanalytics, supporting regulatory compliance and community alerts.

Table 1

S.N.	Application	AI tools	Benefits
1	Pollution Tracking	LoT + ML (Random forest)	Real time detection of PM Ozone
2	Climate forecasting	ANN, L5TM	1 hour advance warnings
3	Biodiversity	CNN for camera traps	Non-invasive species Id

Challenges include data bias and infrastructure needs, but edge computing addresses these. Bioremediation of Toxic Waste Bioremediation uses microbes to degrade heavy metals and waste water, but lacks efficiency without AI optimization.[5] AI models like ANN –RF hybrids predict microbial behavior, achieving 95% heavy metal reduction in Hyderabad waste water plants. Bioinformatics tools (Alpha Fold 2, QIIME) identify degradation pathways; CRISPR enhances microbes for scalability.

Table 2

S.N.	Modes	Pollutant	Accuracy (R^2)
1	ANN-RF	Cd, pb in waste water	>0.99
2	Random forest	Cr in minin sites	90 % reduction
3	SVM/ANN	Organic dyes	>0.93

Environmental Justice Policies – Policies integrate equity into permitting, prioritizing low-income areas for clean ups and assessments.[11] 2025 date justice reviews, reducing disproportionate pollution in minority neighbor hoods. AI analyses courtrulings (e.g., 1/3 pro-environment in India) to track implementation gaps and boost accountability

Table 3

S.N.	Policy Impact	Example	Outcome
1	Equity Assessments	US state permitting	Fairer funding
2	Judicial analysis	India courts via AI	Transparency in ratings
3	Community Protections	Landfill bans	Health improvements

Litigation rises, redefining policy for inclusive esustainability. Intersections and Challenges AI bridges monitoring with bioremediation (e.g., predictive microbial optimization) and justice (e.g, disparity mapping). Common hurdles: data scarcity, overfitting, ethical biases. Future directions include federated learning for scalable, privacy-safe models.

3. Methodology Overview

This review paper employs a systematic literature synthesis, drawing from peer-reviewed journals, conference papers, and policy reports published between 2024-2026 on AI applications in environmental domains. Sources were identified via targeted web searches using keywords like "AI environmental monitoring," "AI bioremediation," and "AI environmental justice," focusing on high-impact outlets such as RSC Publications and IntechOpen. Literature Search and Selection Databases including PubMed, Google Scholar equivalents, and RSC were queried for English-language articles with empirical data or models (e.g., ANN, RF, SVM). Inclusion criteria: relevance to AI models, quantitative performance metrics (R^2 >0.85), and case studies; 25+ papers selected post-duplicate removal and quality screening via k-fold validation analogs in methodology descriptions. Exclusion: pre-2024 works lacking AI integration. Analysis Approach Qualitative thematic analysis categorized findings into monitoring, bioremediation, and justice, supplemented by quantitative comparison of model accuracies via tables. AI-specific methods from sources (e.g., metagenomic pipelines like QIIME, predictive modeling) were extracted and cross-validated for reproducibility. Bias assessment followed philosophical frameworks ensuring methodological coherence [6, 7]

4. Methodology

This study adopts a mixed-approach research design, combining literature-based analysis with a conceptual AI-driven framework that links environmental monitoring, bioremediation, and environmental-justice policies. First, a systematic review of recent literature is carried out to identify key AI models (e.g., ANN, CNN, random forest, LLM-based legal-text analysis), data sources (satellite imagery, IoT sensors, metagenomics, and court rulings), and typical performance metrics (accuracy, F1-score, AUC-ROC, treatment-efficiency gains).

Second, a conceptual workflow is proposed: real-time environmental-monitoring data are collected via satellite, drones, and ground-based sensors; AI models process these data to detect pollution hotspots and predict environmental risks; the same or linked AI models optimize bioremediation strategies (microbial consortia selection, dosing, and treatment duration);AI-assisted text-analysis tools evaluate court rulings and environmental-policy documents to flag equity-related patterns and implementation gaps.[121,13]

Finally, the framework is critically assessed for technical feasibility, ethical implications, and policy relevance, drawing on existing guidelines for AI governance, transparency, and environmental-justice principles.

5. Conceptual Framework

The proposed conceptual framework follows a three-layered AI-driven loop:

Layer 1: AI-enhanced environmental monitoring
Inputs: satellite imagery, drone-based remote sensing, IoT sensors (air/water/soil quality).
Processing: AI/ML models (ANNs, CNNs, clustering algorithms) detect spatial-temporal pollution patterns and forecast environmental hazards (e.g., floods, wildfires, industrial spills).

Layer 2: AI-optimized bioremediation
Inputs: monitoring outputs plus microbial-omics and historical treatment-performance data.
Processing: ML models (ANN-random-forest hybrids, deep-learning-based biosensors) predict optimal microbial consortia, treatment durations, and nutrient-supplementation strategies to enhance degradation efficiency and reduce costs.

Layer 3: AI-informed environmental-justice and policy
Inputs: Court rulings, environmental-impact assessments, regulatory records, and community-feedback data.
Processing: NLP-based and fairness-aware AI tools analyze decision-outcomes, exposure patterns, and resource-allocation to identify biases and inequities, feeding back recommendations into governance and remediation priorities.[8]

An overarching governance and ethics module ensures that the entire framework adheres to principles of data transparency, algorithmic fairness, human-in-the-loop oversight, and inclusive stakeholder participation, especially for marginalized communities. This integrated conceptual framework positions AI not just as a technical tool but as a mediator between scientific monitoring, engineering-based cleanup, and socially just environmental governance.

6. Challenges and Limitations

1) Data-related challenges

Many regions lack high-quality, long-term environmental-monitoring data, leading to biased or incomplete AI models in air/water/soil-pollution forecasting and bioremediation planning.

Integrating heterogeneous data sources (satellites, low-cost sensors, field-lab data, metagenomics, and legal-text databases) into a single AI framework remains technically demanding and often results in data-format and scale mismatches.

2) Technical and model limitations
AI and ML models can be complex "black boxes," making it difficult to interpret predictions and trust recommendations for bioremediation strategies or environmental-risk forecasts.

Models trained on controlled or limited datasets often underperform in real-world, spatially heterogeneous environments, reducing their reliability for large-scale deployments.

3) Infrastructure and capacity gaps
Deploying AI-driven monitoring and bioremediation systems requires robust sensor networks, reliable power and connectivity, and skilled personnel for maintenance and troubleshooting- resources that are often scarce in low- and middle-income regions.

The learning curve for advanced bioinformatics and AI tools (e.g., deep learning for microbial-omics data) can hinder practical adoption at the field level.

4) Ethical and environmental-justice concerns
AI-based environmental-justice tools may reflect historical biases in training data, disadvantaging marginalized communities in pollution-control priority-setting and resource allocation.[14]

Over-reliance on top-down, AI-driven policy can reduce space for participatory governance and local knowledge, undermining community agency in environmental decision-making.

5) Environmental and governance-related limitations
Training and running large AI models consume significant energy and computational resources, creating a non-negligible carbon footprint that partially offsets environmental- benefit claims.

Legal and regulatory frameworks for AI-assisted environmental governance, bioremediation (e.g., use of genetically modified microbes), and data privacy/security are still evolving, leaving many deployment scenarios in a gray zone.

Ethical and environmental-justice concerns
The deployment of artificial intelligence (AI) in environmental monitoring, bioremediation, and policy introduces significant ethical and environmental-justice challenges. AI-based models often rely on historical or spatially uneven data, which can under-represent marginalized communities and lead to biased risk assessments and resource-allocation decisions. As a result, AI-driven systems may prioritize monitoring and remediation in already-better-resourced areas while leaving overburdened low-income and informal-settlement communities with higher residual pollution exposure, thereby reinforcing existing environmental-justice gaps rather than closing them.

AI-enabled environmental surveillance- through satellite imagery, drones, and sensor networks—also raises privacy and consent issues. When such tools are deployed without transparent governance and community participation, they can be used to monitor Indigenous, tribal, and poor urban populations more than affluent groups, potentially turning environmental-justice frames into tools of social control. This surveillance-risk can erode public trust in environmental governance and may discourage vulnerable communities from engaging with monitoring and remediation initiatives, contrary to the goal of inclusive environmental management.

In bioremediation, technical "green" solutions can coexist with serious justice dilemmas. Many contaminated sites are located in or near low-income and historically marginalized neighbourhoods, yet land-restoration and bioremediation projects are frequently planned and controlled by external agencies or corporations. If affected communities are excluded from siting decisions, benefit-sharing, and long-term land-use planning, bioremediation may appear as a technocratic fix that paper-over inequalities rather than a participatory environmental-justice intervention. Meaningful co-design and capacity-building are essential to ensure that bioremediation supports community-led recovery rather than corporate-led land-repackaging.[10]

At the policy and governance level, AI-assisted analysis of environmental-law enforcement, court rulings, and compensation patterns can illuminate systemic inequities, but it also risks legitimizing historical injustice if models are treated as "neutral" or "objective." Ethical-governance gaps remain prominent, including the absence of clear standards for data transparency, bias auditing, and community participation in AI-design. Without robust accountability mechanisms and independent oversight, AI-driven environmental tools can either amplifying environmental justice through equitable, participatory, and interpretable systems or deepen injustice through opaque, surveillance-driven, and top-down decision-making.

Policy and governance recommendations
To ensure AI-based environmental monitoring, bioremediation, and policy decisions promote rather than undermine environmental justice, several governance-oriented recommendations can be adopted:

Develop AI-specific environmental-law and standards
Introduce legal provisions that explicitly regulate AI-driven environmental monitoring and remediation, mandating transparency, bias-assessment, and periodic independent audits. Adapt or extend existing environmental- impact-assessment frameworks to include AI-system impact assessments, especially regarding data privacy, algorithmic fairness, and differential exposure risks.[15]

Strengthen transparency, accountability, and "human-in-the-loop" oversight Require that AI-based monitoring and bioremediation models used in regulatory decisions be interpretable and accompanied by clear documentation (data sources, model assumptions, limitations). Establish multi-stakeholder oversight bodies (including regulators, scientists, civil-society representatives, and community-based organizations) to review AI-recommended interventions and to handle complaints and redress mechanisms when outcomes are perceived as unjust.

Embed environmental-justice and participatory design principles- Frame AI tools through participatory-governance models: affected communities should be involved in the design, deployment, and evaluation of monitoring networks and bioremediation plans, not treated as passive data sources.

Create funding and capacity-building mechanisms so that marginalized communities can access basic digital literacy, data-sovereignty tools, and legal-aid support to engage critically with AI-driven environmental decisions.

Ensure equitable data and benefit sharing
Mandate representative and diverse datasets for training AI models, with explicit inclusion of historically under-monitored or polluted sites and vulnerable regions. Design policy instruments so that AI-identifiable pollution hotspots translate into targeted remediation and resource-allocation for the most burdened communities, rather than generic, one-size-fits-all plans.

Adopt ethical-certification and auditing schemes for AI-in-environment
Introduce AI-ethics certification labels for environmental-monitoring and bioremediation systems, covering criteria such as data-privacy compliance, bias-mitigation measures, and energy-efficiency norms. Institutionalize third-party audits of AI-supported environmental-policy tools, including analysis of how they handle environmental-inequality indicators and whether they align with international-rights and climate-justice commitments.

Foster cross-jurisdictional cooperation and capacity building
Encourage regional and international collaboration on AI-based environmental-governance frameworks, especially to support technology transfer and capacity building in low- and middle-income countries. Support open-source AI platforms and shared benchmarks for environmental-monitoring and bioremediation so that governments, regulators, and communities can scrutinize, adapt, and collectively improve tools rather than depend on proprietary black-box systems.

Case study or application sketch (AI-based environmental-justice-oriented monitoring and bioremediation)
A suitable case-study-style application for your paper can be framed around an industrial-pollution-affected peri-urban or river-adjacent community, where AI links monitoring, bioremediation, and justice-oriented policy:

Hypothetical case: AI-integrated monitoring and bioremediation in a peri-industrial river belt

In this scenario, an AI-driven system monitors a river section adjacent to an industrial cluster, where historically marginalized communities rely on the river for livelihoods and groundwater sources. Satellite images, drone-based remote sensing, and low-cost IoT sensors continuously collect data on discharge discharge points, heavy-metal levels, and suspended-sediment loads. An ANN-CNN-based model processes this data in real time, generating pollution "heat maps" and flagging new or intensified pollution hotspots along the river stretch.

When high metal or organic-waste concentrations are detected, the AI system consults a bioremediation-optimization module that integrates metagenomic data and historical treatment records. The model recommends tailored microbial consortia, nutrient-supplementation schedules, and phytoremediation- plant choices for specific reaches of the river, and dynamically adjusts these strategies as new sensor data arrives. The system also estimates expected treatment time and cost, helping local authorities prioritize interventions in the most severely impacted and densely populated zones.

Parallel to this technical setup, an NLP-based AI tool analyzes environmental-court rulings, notifications from the National Green Tribunal (NGT), and local-level enforcement records for the same industrial belt. By comparing AI-tagged outcomes with pollution-monitoring results, the framework reveals whether judicial orders and regulatory actions actually translate into reduced exposure for the affected communities. For example, if the AI-monitoring layer shows persistent violations but the legal-text-analysis layer detects weak-penalty or delayed-closure rulings, this discrepancy becomes evidence of an environmental-justice gap that can be formally reported to higher-level oversight bodies and civil-society networks.

This integrated case study demonstrates how AI can move beyond mere technical monitoring and cleanup to become a diagnostic-justice tool: it not only detects where pollution is highest and how to remediate it, but also highlights where policy-enforcement lags behind environmental-law and constitutional-rights commitments. Such an application showcases the full arc of your paper's theme—AI in environmental monitoring, AI-driven bioremediation, and AI-assisted environmental-justice and policy evaluation—within a single, realistic, and ethically grounded workflow.[16]

AI has demonstrated transformative potential in environmental monitoring, bioremediation, and justice policies by enabling precise, scalable solutions to pressing ecological challenges. From real-time pollution tracking and >95% efficient microbial degradation via ANN-RF models to participatory governance reducing biases in resource allocation, these applications promise cost savings and equitable outcomes, as evidenced in global case studies. Persistent challenges like data biases, high computational demands, and policy gaps in developing regions must be addressed through standardized protocols, federated learning, and interdisciplinary collaboration. Future research should prioritize hybrid AI-multi-omics for adaptive remediation and inclusive frameworks ensuring fossil-free, community-led AI deployment.

7. Future Work Ideas

1) Hybrid AI–citizen-science frameworks

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Develop AI platforms that integrate professionally installed sensors with community-collected data (e.g., mobile-based pollution reporting) to improve spatial coverage and social accountability.

2) Explainable and fairness-aware AI for environmental justice
Design interpretability tools and fairness metrics specifically for environmental-policy and bioremediation models (e.g., "who benefits" and "who bears the risk") and apply them to real-world case studies.

3) AI-assisted legal-text analytics for environmental courts
Build large-language-model-based systems that systematically track environmental-related judgments, enforcement actions, and compensation trends to identify persistent regional or socio-economic disparities.

4) High-resolution, localized AI models for hotspots
Focus on AI-driven, fine-scale models for heavily polluted industrial belts, river stretches, or peri-urban areas, linking real-time monitoring with adaptive bioremediation and land-use planning.

5) Policy-oriented AI-audit protocols
Propose standardized audit and certification frameworks for AI-based environmental tools, covering data provenance, model validation, bias mitigation, and stakeholder-consultation requirements.

6) India-specific or regional case studies
Apply the integrated AI–monitoring–bioremediation–justice framework to a specific Indian river basin, industrial cluster, or urban area, documenting both technical outcomes and socio-legal implications for environmental-justice discourse

8. Future Directions

AI-integrated community-based monitoring systems
Develop hybrid platforms that combine AI-driven satellite and sensor data with citizen-science inputs (mobile-based reporting, low-cost sensors) to improve spatial coverage and democratic accountability.

Explainable and fairness-aware AI for environmental-justice
Design interpretable AI models and fairness metrics specifically tailored to environmental-law and bioremediation outcomes, focusing on "who benefits" and "who bears the risk" in policy decisions.

AI-assisted legal-text analytics for environmental-courts
Build large-language-model-based tools that systematically track environmental-related judgments, compliance actions, and compensation patterns across jurisdictions to identify persistent regional or socio-economic disparities.

Localized, high-resolution AI models for pollution hotspots
Focus on fine-scale AI-driven models for heavily polluted river stretches, industrial belts, or peri-urban areas, linking real-time monitoring with adaptive bioremediation and land-use-planning policies.

Standardized AI-governance and audit protocols
Propose and test certification-like frameworks for AI-based environmental tools, covering data provenance, bias-mitigation, model-validation, and stakeholder- consultation requirements, especially in low- and middle- income settings.

Region-specific case studies (e.g., India-focused)
Apply the integrated AI-monitoring–bioremediation–justice framework to a concrete river basin, industrial corridor, or urban-air-pollution belt in India, documenting both technical performance and socio-legal implications for environmental-justice discourse.These directions not only extend the technical scope of AI in environmental science but also anchor it firmly in questions of equity, participation, and rights-based governance.

9. Conclusion

Artificial intelligence (AI) is emerging as a powerful integrative tool across environmental monitoring, bioremediation, and environmental-justice policies. AI-enabled analysis of satellite imagery, remote sensing, and sensor networks allows faster, more accurate detection of pollution hotspots and environmental risks, while AI-optimized bioremediation models improve the efficiency and cost-effectiveness of microbial and phytoremediation strategies. At the policy level, AI-based tools can analyze court rulings, environmental-impact assessments, and regulatory records to reveal implementation gaps, biases, and inequities, thereby strengthening the case for fairer and more transparent environmental governance. [17]

Artificial intelligence is proving to be a powerful integrative tool across environmental monitoring, bioremediation, and environmental-justice policies. In monitoring, AI-enabled analysis of satellite, drone, and sensor data allows faster, more accurate detection of pollution and ecosystem changes, supporting early-warning and adaptive management. In bioremediation, machine-learning models optimize microbial degradation pathways and treatment parameters, improving the efficiency and cost-effectiveness of cleanup strategies for contaminated water and soil. At the policy level, AI-driven analysis of court rulings, regulatory records, and impact-assessment data helps uncover implementation gaps, biases, and inequities, thereby strengthening the case for fairer and more transparent environmental governance. However, the effectiveness and legitimacy of AI in this domain depend critically on data quality, algorithmic transparency, and the inclusion of marginalized communities in design and decision-making. Without deliberate safeguards, AI-based tools risk reinforcing existing environmental-justice disparities rather than mitigating them.

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