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Climate Change and Green Technology: A Comprehensive Scientific and Legal Scrutiny

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Abstract

This research article presents a critical examination of the dual identity of climate change as both a geographical phenomenon and a complex legal construct. By tracing the historical trajectory of resource exploitation driven by industrial expansion, the paper identifies the systemic roots of contemporary environmental degradation. It evaluates the evolution of environmental jurisprudence through a comparative analysis, highlighting the contributions of judicial pioneers in India and the international community. Moving beyond problem identification, the article provides a detailed, solution-oriented roadmap, prioritizing the integration of green technology, specifically green hydrogen, AI-driven carbon capture, smart urban resilience, and precision agriculture within a robust legislative framework. The inquiry concludes that achieving ecological sustainability requires a "planetary perspective" in law that balances economic imperatives with the fundamental right to a stable environment.

Introduction: The Jurisprudential Identity of Climate Change

The current world has a huge environmental problem that requires a serious blend of new science and changes in laws. Climate change, which we usually think of as long-term changes in temperature and weather, has turned into a complex legal issue. In legal terms, it means there is an ongoing change in the climate caused either directly or indirectly by what people do that changes the air around the Earth, or by natural events like volcanic eruptions and solar cycles.

Since the start of the Industrial Revolution, the constant quest for profit has often pushed aside moral and environmental concerns, leading to the overuse of our natural resources. This history has caused major problems like the quick depletion of the ozone layer, higher sea levels, and a big loss of animal species, with many facing extinction and global food systems being seriously affected. The need for awareness and new laws about this issue is not just a choice anymore; it is crucial for the survival of humans and to stop future conflicts over resources.

Philosophical Foundations and the Ethics of Climate Justice

The balance between growth and protecting nature is a must according to the law, not just a choice. The courts in India have repeatedly said that we can't have strong economic growth if it means harming the environment. This understanding has led to the idea of "sustainable development," which tries to blend industry advancements with caring for the environment.

Looking at climate change also involves thinking about fairness, known as climate justice. This approach focuses on people and connects basic human rights with the need for development. Unlike the usual environmental justice that aims to enforce laws against local pollution, climate justice is about making sure that those who are most affected by climate issues are treated fairly and that the responsibilities and

advantages of climate actions are shared fairly over time. This view is based on scientific findings and recognizes that we need to manage the Earth's limited resources responsibly.

The Indian Constitutional Mandate

In India, having a clean environment is now considered a basic right according to Article 21 of the Constitution, which protects the right to life and personal freedom. This change came with the important case of Rural Litigation and Entitlement Kendra versus the State of Uttar Pradesh in 1985, often referred to as the Dehradun Mussoorie Hills Quarrying Case. The Supreme Court decided that protecting the environment was more important than allowing businesses to mine limestone, recognizing the serious damage it was causing to the Himalayan area. This case set a new standard that the right to life includes the right to clean air and water, which is now a key part of environmental law in India.

The Evolution of Customary International Law

The change from focusing only on industry to being more aware of the environment is shown by how global rules are included in local laws. In the case of Vellore Citizens Welfare Forum v. Union of India, the Supreme Court looked into whether the idea of sustainable development is now part of recognized international law. The court decided that ideas like the "Precautionary Principle" and the "Polluter Pays Principle" are key parts of sustainable development. The Precautionary Principle says that if there is a chance of serious or lasting harm, not having complete scientific evidence shouldn't be a reason to delay effective actions to protect the environment.

Pioneers of Environmental Jurisprudence: The Architects of Change

The development of modern environmental legal frameworks is the result of proactive judicial intervention and the efforts of dedicated activists and scientists.

The Indian Vanguard

1. **Justice Kuldip Singh:** Known as the "Green Judge," his important decisions brought key global ideas into Indian law. His judgment in the Taj Trapezium Case played a vital role in safeguarding the Taj Mahal from harmful pollution caused by industries, showing how the courts can enforce environmental rules against strong business interests.
2. **M. C. Mehta:** He is one of the leading environmental lawyers in India, and his Public Interest Litigation (PIL) has resulted in major court decisions. His important work includes the Ganga Pollution Case and the Shriram Food and Fertilizers Case (Oleum Gas Leak case), where he set up the idea of "absolute liability" for dangerous industries.
3. **Justice V. R. Krishna Iyer and Justice P. N. Bhagwati:** Justice Krishna Iyer's rulings often showed a strong concern for keeping the environment safe, especially in the Ratlam Municipality v. Vardichand case in 1980. Justice P. N. Bhagwati is famous for his wide understanding of Article 21, making environmental issues a key part of human rights in India.

The International Visionaries

1. **Maurice Strong:** He was the first leader of the UN Environment Programme (UNEP) and was very important in spreading the environmental movement all over the world. He organized the big meetings in Stockholm in 1972 and in Rio in 1992.

2. **Gro Harlem Brundtland:** Known as the “mother of sustainable development,” she led a group that created a report called "Our Common Future" in 1987. This report gave a definition of sustainable development that many people agree on worldwide.
3. **Dr. James Hansen:** He is a well-known expert on climate who spoke in front of Congress in 1988, which helped people understand climate issues better. Later, he stood up for "future generations" in a court case called Juliana v. United States, connecting climate science to legal matters.

Landmark International Litigation: Shaping State Responsibility

The worldwide issue of climate change has caused a rise in global lawsuits where courts are making countries responsible for their climate actions based on human rights agreements and their duty to care for people.

Urgenda Foundation v. State of the Netherlands (2019)

The Urgenda case is a major event in global climate law because it's the first time a court told a government to decrease greenhouse gas emissions for reasons beyond just following laws. The Dutch Supreme Court decided that the Netherlands has a duty under Articles 2 (the right to life) and 8 (the right to privacy and family life) of the European Convention on Human Rights to take reasonable steps to fight climate change. The court did not accept the government’s claim that actions by a small country wouldn’t matter, stating that every bit of pollution people create adds to dangerous climate change.

Neubauer, et al. v. Germany (2021)

The German Federal Constitutional Court canceled some parts of Germany’s Federal Climate Protection Act because they did not align with basic rights. The court introduced the idea of "intertemporal guarantees of freedom," saying that the government cannot simply push the responsibility of cutting emissions onto future generations. By using up most of the "carbon budget" quickly, the lawmakers were unfairly limiting the future choices of young people. The responsibility to achieve climate neutrality was seen as something that can be taken to court under Article 20a of their Basic Law.

Leghari v. Federation of Pakistan (2015)

In the Global South, the case of Leghari marks a shift towards recognizing rights in climate lawsuits. Ashghar Leghari, a farmer, took the Pakistani government to court for not following its National Climate Change Policy. The Lahore High Court decided that the government's slow response was a violation of the basic rights to life and dignity. The court pointed out that for countries that are at risk, issues of climate justice and "water justice" are closely connected, and it set up a Climate Change Commission to ensure the policy is put into action.

Advisory Opinions of 2024 and 2025: ITLOS and ICJ

In May 2024, the International Tribunal for the Law of the Sea, known as ITLOS, made an important decision that confirmed that human-made greenhouse gas emissions are a form of pollution in the ocean according to the UN rules. This means countries are required to take "all necessary measures" to stop this kind of pollution. Then, in July 2025, the International Court of Justice, or ICJ, gave a unanimous opinion stating that countries have legal responsibilities under international law to protect the climate. The ICJ highlighted that these responsibilities are owed to everyone in the global community.

Comparative Analysis of Global Legislative Frameworks

To effectively fight climate change, well-structured laws are needed, moving from just plans to enforceable legal requirements.

The UK Climate Change Act 2008

The UK's Climate Change Act is recognized worldwide as a leading example. It set a legally binding goal to reach Net Zero emissions by 2050. A major part of this is the "carbon budgets," which set limits on the total greenhouse gases the UK can release every five years, offering clarity and stability for long-term investments in greener technologies.

The EU Taxonomy and Carbon Border Adjustment Mechanism (CBAM)

The European Union has created a detailed system called the EU Taxonomy, which defines what counts as environmentally friendly business activities and helps fight against "greenwashing. " Along with this, there is the Carbon Border Adjustment Mechanism (CBAM) that will fully start on January 1, 2026. CBAM ensures that there is an appropriate cost for the carbon produced while making heavy products like steel, cement, and hydrogen that come into the EU, which helps to stop "carbon leakage" to countries with less strict rules.

India's Legislative Evolution: The Jan Vishwas Act 2023

In the past, India's environmental laws mainly used penalties that often caused delays in court cases. The Jan Vishwas (Amendment of Provisions) Act 2023 is starting to change this by making minor environmental violations less of a crime under the Air and Water Acts. Instead of criminal charges, these offenses will result in fines, which is hoped to build more trust in how governance works. Nevertheless, there are still issues with how the National Clean Air Programme (NCAP) is carried out, as a surprising 67% of the budget goes to controlling dust on roads but ignores pollution from factories and burning biomass.

Green Technology Solutions: The Scientific Frontier

Using new technology is crucial for tackling climate problems. While laws encourage action, green technology supplies the necessary resources.

Green Hydrogen: The Clean Energy Carrier of 2030

- India's National Green Hydrogen Mission (NGHM) aims to make the country a leading producer, with a goal of creating 5 Million Metric Tonnes (MMT) of hydrogen each year by 2030.
- Proton Exchange Membrane (PEM) Electrolysis: This method quickly responds to power from renewable sources, and recent advancements using AI have cut energy use by 10%.
- Solid Oxide Electrolyzer Cells (SOEC): These cells work at high temperatures and can achieve more than 90% efficiency by reusing heat from industrial activities.
- Flash Joule Heating (FJH): This new technique heats up plastic waste at high temperatures to create hydrogen and valuable graphene, which supports goals of a circular economy.

Carbon Capture and Storage (CCS): Decarbonizing Hard-to-Abate Sectors

- CCS technology has shown it can cut CO2 emissions from industrial sites by 85–95%.

- Norway's Northern Lights Project: The first facility in the world for cross-border transport and storage started in 2025, sending liquid carbon dioxide deep underground, 2,600 meters beneath the North Sea.
- Brevik CCS: The cement plant owned by Heidelberg Materials in Norway captures 400,000 tonnes of CO2 every year, providing a worldwide model for reducing carbon emissions in industry.
- AI in CCS: Machine learning and digital twins are now applied to improve how leakage is detected with 95% accuracy and to make the solvents used for capture more effective.

Smart Cities and Urban Resilience

Using eco-friendly building methods, from the start of a project to when it ends, is really important.

- **Smart Waste Management:** Technology like AI smart bins made by Ameru can spot and sort trash right away using cameras, making it easier to organize waste.
- **Green Construction:** In India, big housing groups must have rainwater collection systems and Sewage Treatment Plants (STPs) set up, according to state pollution boards. The Rooftop Solar Scheme helps cover up to 60% of the cost for putting in solar panels, which helps lessen the need for coal-powered energy.

Sustainable Agriculture and Biotechnology

- Climate-smart Agriculture, or CSA, helps make sure we have enough food while also cutting down on harmful emissions.
- Precision Farming: This method uses tools like GPS, IoT sensors, and drones to check on soil health and manage water and fertilizers based on what is needed, which lessens chemical usage by 25%.
- Biotechnology: Scientists are using CRISPR-Cas9 technology to create new types of rice and wheat that can survive droughts and high temperatures.
- Agrivoltaics: Using land for both farming and solar energy production is getting more attention from the government in India as a way to improve life in rural areas.

Sustainable Finance: The Engine of Transition

Getting enough money is the main hurdle to growing green solutions.

Sovereign Green Bonds

In 2023, India introduced its first Sovereign Green Bonds, raising $2 billion to support projects in renewable energy, clean transportation, and managing water resources. These bonds come with a government guarantee that makes investing safer and helps lower costs for important green projects.

Green Credit Rules 2025

In August 2025, the Ministry of Environment announced new Green Credit Rules that changed the focus from just planting trees to truly restoring ecosystems. The updated rules require a five-year upkeep period and at least 40% canopy cover before credits can be earned, closing the "plant-and-forget" loophole that was a problem in past programs.

Legislative Roadmap: Suggestions for Change

To really protect the environment, we suggest the following changes to laws and rules:

1. **Updating the Air Act from 1981:** Instead of focusing only on individual cities, we should look at air

quality across regions to better tackle pollution that crosses borders and emissions from vehicles.

2. **Single Climate Law:** India should create a detailed Climate Change Law similar to what the UK has, to legally commit to reaching Net Zero by 2070 and to establish a system for tracking carbon output.
3. **Strengthening Institutions:** Pollution Control Boards should be given more money and freedom to make decisions, with better-trained staff and updated technology to stop outside influence on regulations.
4. **Involving Indigenous People:** We need to set up official ways for Indigenous and forest communities to have a say in environmental decisions, using their deep knowledge of nature, like programs in Canada and Australia.

Conclusion: Towards Global Environmental Management

Studying climate change shows that while it's a serious problem, the answers are becoming clearer. Moving from environmental justice to climate justice means we are starting to focus more on helping vulnerable people and future generations. New technologies like green hydrogen and AI-based carbon capture could help us grow the economy without increasing carbon emissions, as long as there is a clear and responsible legal system in place. In the end, protecting our planet is not just about choosing growth or conservation; it is a basic requirement of our laws and a moral duty to keep life thriving.

References and Bibliography

1. *See* United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107.
2. *Rural Litigation and Entitlement Kendra v. State of U.P.*, (1985) 2 S.C.C. 431.
3. *Leghari v. Federation of Pakistan*, W.P. No. 25501/2015 (Lahore H.C. Sept. 4, 2015).
4. *State of the Netherlands v. Urgenda Found.*, ECLI:NL:HR:2019:2007 (Sup. Ct. Neth. Dec. 20, 2019).
5. *Vellore Citizens Welfare Forum v. Union of India*, (1996) 5 S.C.C. 647.
6. *Neubauer v. Germany*, 1 BvR 2656/18 (BVerfG Mar. 24, 2021).
7. *M.C. Mehta v. Union of India* (Ganga Pollution), (1987) 4 S.C.C. 463.
8. *See* Maurice Strong Biography, UNEP, https://www.unep.org/unep-50-leaders-through-years/maurice-strong (last visited Jan. 27, 2026).
9. *World Comm'n on Env't & Dev., Our Common Future* (1987).
10. *Juliana v. United States*, 947 F.3d 1159 (9th Cir. 2020).
11. *Advisory Opinion on Climate Change and International Law*, Case No. 31, ITLOS Rep. (May 21, 2024).
12. *Advisory Opinion on the Obligations of States in Respect of Climate Change*, 2025 I.C.J. 1 (July 23).
13. Climate Change Act 2008, c. 27 (UK).
14. Jan Vishwas (Amendment of Provisions) Act, 2023, No. 18, Acts of Parliament, 2023 (India).
15. *See* Ministry of New & Renewable Energy, *National Green Hydrogen Mission*, https://mnre.gov.in (last visited Jan. 27, 2026).
16. *See* Northern Lights Project, Equinor (2025).
17. *See* Smart Bin Systems for Optimized Waste Management, 15 Int'l J. Sci. & Res. Archive 325 (2025).
18. Green Credit Rules, 2025, Gazette of India, pt. II sec. 3(i) (Aug. 29, 2025).
19. *See* UNDP India, *India Legal and Policy Framework for Air Quality* (Jan. 31, 2025).
20. *See* Vishal Chaudhary, *Environmental Laws and Indigenous Rights in India: A Comparative Analysis* (Apr. 2025).