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About E-magazine

“Earth Root” is an open access e-magazine in the discipline of Environmental sciences published by Earth Root Foundation. The aim of the e-magazine is to provide information and upgradation of knowledge about environmental issues on wider scale and to share ideas and resources to the readers. Using essential knowledge people can lead a healthy life, which is more sustainable and can connect with ongoing efforts for stopping catastrophically the climate change. E-magazine caters to all related environmental aspects ranging from big issues like climate change, renewable energy and pollutants in the atmosphere to the health of human and living beings on Earth. We also take topics of water resources and efforts and measurement to provide optimum use of it; including large scale atmospheric circulation linked with oceans and ecology.

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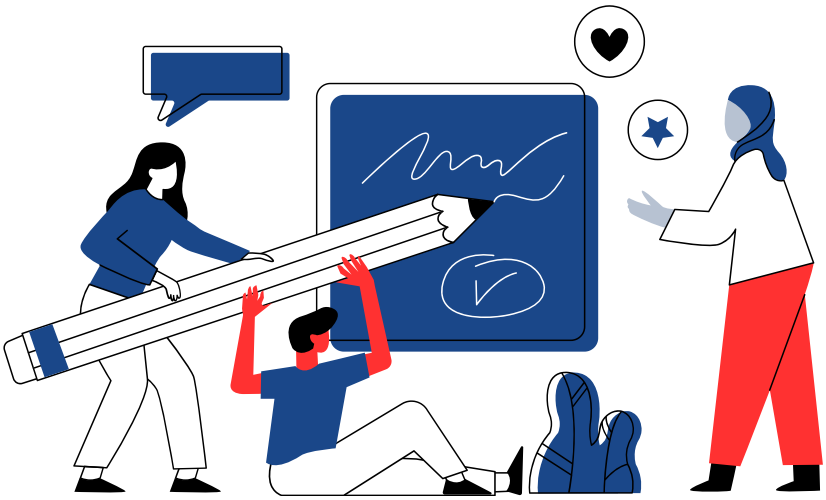

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DELHI NCR'S BATTLE AGAINST POLLUTION: A CRISIS IN THE AIR

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The pollution levels in the Delhi NCR region have become an annual crisis, impacting health, daily life, and the environment on an unprecedented scale. Each year, as winter approaches, Delhi's air quality plunges to hazardous levels, earning the city a notorious reputation as one of the world's most polluted capitals. A combination of factors—ranging from vehicular emissions to agricultural practices—drives this pollution, leaving residents in constant concern over the quality of the air they breathe.

Delhi's air pollution is largely attributed to particulate matter, primarily PM2.5 and PM10, which are microscopic particles that penetrate the lungs and enter the bloodstream. In recent years, these levels have consistently exceeded the safe limits set by the World Health Organization (WHO) and India's Central Pollution Control Board (CPCB). According to data, PM2.5 levels in Delhi often reach 500 micrograms per cubic meter or more during the winter months, far exceeding the WHO guideline of 15 micrograms per cubic meter for an average 24-hour period. The severity of these readings places Delhi's air quality in the "severe" category, posing serious health risks, particularly to vulnerable populations like children, the elderly, and those with pre-existing respiratory conditions.

One major contributor to Delhi's pollution crisis is vehicular emissions. With a high population density and a significant number of vehicles on the road, transportation emissions account for a substantial portion of the air pollution. According to the System of Air Quality and Weather Forecasting and Research (SAFAR), vehicles are responsible for up to 41% of PM2.5 pollution on an annual basis. Diesel-powered vehicles, in particular, produce high levels of nitrogen oxides (NOx) and particulate matter, adding to the toxic load in the air.

Industrial activities in and around Delhi NCR also play a significant role in deteriorating air quality. The region is home to numerous factories and power plants, many of which are fueled by coal, a major source of sulfur dioxide and particulate emissions. Despite regulations, the enforcement of pollution control measures in these industries remains inconsistent, contributing

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to the region's pollution woes. Emissions from these industries mix with pollutants from vehicles and other sources, creating a thick smog that blankets the city.

Another seasonal factor that exacerbates pollution in Delhi is the practice of crop stubble burning in neighboring states like Punjab, Haryana, and Uttar Pradesh. After the harvest season, farmers burn leftover crop residue to clear fields quickly and prepare them for the next sowing season. This practice, while economically convenient, releases large amounts of PM2.5 and PM10 particles, along with carbon monoxide and other harmful gases. Every year, satellite imagery shows plumes of smoke from these states drifting toward Delhi, contributing significantly to the winter smog. Despite government efforts to provide alternatives, such as subsidies for crop residue management machines, the practice continues due to limited awareness and financial incentives for small-scale farmers.

Meteorological conditions during the winter months exacerbate pollution in the Delhi NCR region. With cooler temperatures and weaker winds, pollutants become trapped close to the ground, a phenomenon known as temperature inversion. This layer of stagnant air prevents pollutants from dispersing, allowing them to accumulate and create dense, lingering smog. Consequently, the air quality deteriorates sharply during the winter season, with some days marked as "severe" or even "emergency" levels on the Air Quality Index (AQI).

The health impact of this persistent pollution is alarming. Studies have shown a direct link between poor air quality in Delhi NCR and a rise in respiratory illnesses, cardiovascular diseases, and other health problems. According to a study by the Indian Council of Medical Research (ICMR), long-term exposure to high pollution levels is associated with reduced life expectancy. The Global Burden of Disease study estimated that air pollution contributes to over one million deaths annually in India, with Delhi NCR being a major contributor. Health experts also report a rise in asthma, chronic obstructive pulmonary disease (COPD), and even mental health issues, as residents deal with prolonged exposure to toxic air.

Efforts to address Delhi's pollution crisis have been extensive, yet the results remain inconsistent. The government has implemented the Graded Response Action Plan (GRAP), which proposes emergency measures like halting construction activities, restricting vehicular movement, and shutting down industries based on pollution levels. During peak pollution days, authorities may also close schools and advise residents to stay indoors. While these measures are necessary, they are largely reactive, focusing on short-term mitigation rather than long-term solutions.

The promotion of electric vehicles (EVs) is a promising step toward reducing vehicular emissions, with Delhi NCR rolling out policies to incentivize EV adoption. The Delhi government has introduced subsidies and set up charging infrastructure across the city to make EVs more accessible to residents. Additionally, efforts are being made to transition public transportation to cleaner fuels like compressed natural gas (CNG) and to increase the green cover within the city through afforestation drives. However, the impact of these measures will take time, given the scale of the problem.

Public awareness and community involvement are crucial in the fight against pollution. Awareness campaigns, especially those that educate people about the health impacts of pollution and the steps they can take to reduce their own footprint, can empower individuals to take action. Simple behavioral changes, such as carpooling, using public transport, and reducing waste, contribute to reducing pollution. Additionally, active citizen engagement can press for stricter enforcement of environmental regulations and encourage more sustainable practices in industries and agriculture.

Addressing Delhi NCR's pollution crisis requires government action, technological innovation, and public participation. This is essential for improving quality of life and setting an example for other cities. With collective efforts, there is hope for a cleaner future in Delhi NCR.

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COP29: A TURNING POINT FOR GLOBAL CLIMATE ACTION

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The upcoming COP29 conference holds significant global attention as countries prepare to discuss critical strategies to address climate change and assess progress toward the goals of the Paris Agreement. COP29, the 29th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), will be hosted by the United Arab Emirates in 2024. It presents an important opportunity for nations to evaluate their climate action commitments, advance financing for adaptation and mitigation efforts, and tackle pressing environmental issues that demand urgent and coordinated action.

This conference comes at a critical time, as the impacts of climate change are becoming increasingly severe across the world. With record-breaking heatwaves, devastating floods, prolonged droughts, and intense storms becoming more frequent, the urgency for impactful policies and concrete actions has never been greater. Scientists have consistently warned that if global temperatures continue to rise at the current rate, the planet will likely exceed the 1.5°C warming threshold within the next decade, leading to irreversible changes in ecosystems and climate patterns. COP29's agenda will, therefore, revolve around not just mitigation but also resilience and adaptation strategies for countries already grappling with these adverse impacts.

One of the most anticipated topics at COP29 is the global stocktake of climate commitments. This process, mandated by the Paris Agreement, assesses whether current national efforts are sufficient to meet the collective target of limiting global temperature rise to well below 2°C, with an aim to keep it within 1.5°C. The stocktake will provide a clear picture of where countries stand in terms of their Nationally Determined Contributions (NDCs), the voluntary commitments made by each nation to reduce greenhouse gas emissions and adapt to climate impacts. Many countries have updated their NDCs over the past few years, but a significant gap remains between pledged actions and the reductions needed to achieve the Paris goals. COP29 will likely push for more ambitious targets and greater accountability mechanisms to ensure nations uphold their commitments.

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Financing for climate adaptation and mitigation will also be a central theme. Developing countries, particularly those in regions most vulnerable to climate impacts, have long called for increased financial support from wealthier nations. In previous COP sessions, developed countries committed to providing $100 billion annually by 2020 to assist developing countries, yet this target has not been fully met. COP29 will aim to address this shortfall and explore new ways to mobilize funding, including through climate finance institutions, public-private partnerships, and debt-for-climate swaps. Furthermore, the Loss and Damage Fund, established during COP27 to compensate vulnerable nations for irreversible climate damages, will be a critical area of focus as countries work to operationalize and fund this initiative effectively.

Another significant issue for COP29 will be the transition to renewable energy and phasing out of fossil fuels. With fossil fuels accounting for a large portion of global greenhouse gas emissions, shifting to clean energy sources is essential to meet climate targets. The United Arab Emirates, as the host country, has announced plans to advocate for “pragmatic” energy transitions that support economic growth while reducing emissions. However, as one of the world’s leading oil producers, the UAE’s role as a COP host has sparked some controversy, with critics questioning whether meaningful commitments to phasing out fossil fuels can be achieved. Nonetheless, this could also be an opportunity for oil-producing nations to demonstrate leadership by committing to substantial investments in renewable energy and carbon capture technologies.

Technological innovation and carbon markets will also be on the agenda at COP29. Carbon markets, as established in Article 6 of the Paris Agreement, enable countries to trade emissions credits, providing flexibility in meeting emissions targets. This approach has gained traction, yet it requires robust regulatory frameworks to prevent misuse and ensure that emission reductions are genuine and verifiable. Additionally, advancements in technology, such as carbon capture, utilization, and storage (CCUS), offer promising solutions for reducing emissions in hard-to-abate sectors, and COP29 will likely promote greater collaboration on deploying these technologies on a large scale.

Public awareness and civil society engagement will play an influential role in COP29 as well. Youth activists, environmental organizations, and indigenous groups have consistently advocated for stronger action on climate change, and their voices will be crucial in holding governments accountable. Recent climate protests and advocacy efforts highlight the growing impatience of global citizens who demand urgent, effective policies to secure a sustainable future. Civil society participation in COP29 is expected to bring additional pressure on policymakers to deliver concrete outcomes.

The COP29 meeting represents a critical juncture in the global fight against climate change. With the stakes higher than ever, the decisions made at this conference will shape the planet’s trajectory in the coming decades. As the world watches closely, COP29 presents a unique opportunity for countries to demonstrate genuine commitment, forge stronger partnerships, and take meaningful steps toward a resilient, sustainable future for all.

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TACKLING GLOBAL GREENHOUSE GAS EMISSIONS FOR A SUSTAINABLE FUTURE

-Ankur Goel
Director, Copper Cross Solutions

Global greenhouse gas emissions remain one of the most pressing challenges facing our planet today, driven largely by human activities that fuel economic growth yet threaten ecological balance. The complex interactions between natural processes and human-driven emissions intensify climate change, creating a ripple effect on global ecosystems, economies, and societies.

At the heart of the issue lies carbon dioxide, primarily released from burning fossil fuels for energy and transportation. Since the industrial revolution, reliance on coal, oil, and natural gas has exponentially increased atmospheric CO_2 levels. Modern lifestyles, with their demand for electricity, heating, and mobility, further escalate emissions. Deforestation, especially in rainforests, reduces the planet's capacity to absorb carbon, compounding the problem as carbon stored in trees and soil is released when forests are cut down or burned. The loss of green cover impacts biodiversity, water cycles, and carbon sequestration, weakening the natural mechanisms that counteract emissions.

Methane, another potent greenhouse gas, is produced through agriculture, particularly from livestock and rice paddies, as well as through oil and gas extraction processes. While methane persists in the atmosphere for a shorter period than carbon dioxide, it is much more effective at trapping heat, making its contribution to climate change significant despite lower overall emissions compared to CO_2. Nitrous oxide, emitted from fertilizers and other agricultural activities, also contributes to the greenhouse effect, while fluorinated gases from industrial processes, although present in smaller quantities, are thousands of times more impactful in terms of global warming potential.

The impact of these emissions is multifaceted. Rising global temperatures, which have already exceeded pre-industrial levels by approximately 1.2°C, are linked to melting polar ice caps, rising sea levels, and more frequent and severe weather events. Floods, droughts, wildfires, and hurricanes have become more common and intense, affecting millions of lives and causing extensive economic damage. Coastal communities face displacement, agricultural yields are threatened by unpredictable weather, and water resources are strained in regions where warming affects rainfall patterns.

The consequences are particularly severe for developing nations that have fewer resources to adapt to climate impacts. While they contribute less to global emissions, these regions bear a disproportionate burden of climate-related challenges, from food insecurity to health risks due to extreme heat and poor air quality. In cities worldwide, air pollution from transportation and industrial activities not only worsens global warming but also poses immediate health risks, leading to respiratory and cardiovascular diseases.

Despite the challenges, many nations and organizations are taking steps to address greenhouse gas emissions. The Paris Agreement, signed in 2015, marked a global commitment to limit temperature rise to below 2°C above pre-industrial levels, with efforts to keep it within 1.5°C. Nations pledged to reduce their emissions through Nationally Determined Contributions (NDCs) and to enhance adaptation and resilience against climate impacts. However, progress has been mixed, with some countries on track to meet their targets, while others struggle due to economic and political constraints. In many cases, even current targets are not sufficient to meet the desired global temperature goals, and there are calls for more ambitious action.

Renewable energy sources, such as solar, wind, and hydro, offer pathways to reduce reliance on fossil fuels. Technological advancements have made these options more accessible and cost-effective, contributing to a global shift towards cleaner energy. However, challenges remain in integrating renewables into existing power grids and in ensuring a stable supply, particularly in regions where sunlight and wind availability vary seasonally. Energy storage solutions and smart grids are being developed to address these issues, but widespread implementation requires substantial investment and infrastructure changes. In addition to energy transition, efforts to improve energy efficiency are crucial. Reducing energy consumption in buildings, transportation, and industry through better design, insulation, and technology can significantly lower emissions. Electric vehicles, for example, have gained popularity as a way to decarbonize the transport sector, yet the carbon footprint of producing batteries and the reliance on clean electricity remain issues to be addressed.

The role of nature-based solutions is also increasingly recognized. Reforestation, afforestation, and sustainable land management practices can enhance carbon sinks and restore ecosystems. By protecting wetlands, mangroves, and peatlands, which are natural carbon stores, countries can reduce emissions and bolster resilience against climate change impacts. These practices also provide additional benefits, such as biodiversity conservation and water regulation, which support human well-being.

The business sector is under pressure to adopt sustainable practices, with many companies committing to net-zero goals and seeking ways to reduce their carbon footprint. Carbon markets and carbon pricing mechanisms have emerged as tools to incentivize emissions reduction, allowing companies to offset their emissions by investing in projects that capture or reduce greenhouse gases. However, effective regulation and transparent reporting are essential to prevent greenwashing and ensure that such mechanisms drive real impact.

Public awareness and behavior also play a critical role in addressing greenhouse gas emissions. Individuals can contribute by making sustainable choices, from reducing energy use to adopting plant-based diets, which can lower methane emissions from livestock. Waste reduction and recycling help minimize emissions from waste management processes, and collective shifts towards greener lifestyles can influence market demand and policy directions.

Addressing global greenhouse gas emissions requires coordinated efforts across sectors and borders. The solutions must be collaborative, inclusive, and adaptable to changing conditions. While the path is challenging, the transition to a sustainable and resilient world is possible with the combined efforts of governments, businesses, communities, and individuals.

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UNDERSTANDING DELHI'S FOG CRISIS IN OCTOBER AND NOVEMBER: CAUSES, TRENDS, AND THE IMPACT OF AGRICULTURAL SHIFTS

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Delhi’s smog crisis every October and November has worsened significantly in recent years, driven by a combination of agricultural practices, environmental policies, and unfavorable meteorological conditions. The problem is far more pronounced than it was a decade ago due to shifts in farming methods, timelines, and intensities, particularly with rice harvesting and stubble burning in Punjab and Haryana. Here’s a detailed look at the causes of Delhi’s fog and smog crisis, and how agricultural changes have intensified the issue.

The Seasonal Smog Crisis in Delhi: October-November

Delhi’s annual fog in late autumn is not just a natural occurrence but a dangerous mix of smoke, particulate matter, and fog, often termed "smog." This fog contains high levels of pollutants that impact visibility, respiratory health, and overall air quality, creating a public health crisis. Several factors contribute to this phenomenon, with agricultural practices in nearby states playing a major role.

Key Contributing Factors

Stubble Burning in Punjab, Haryana, and Other Neighboring States

Stubble burning remains one of the largest contributors to Delhi’s pollution during this period. As farmers in states like Punjab and Haryana finish their rice harvest, they burn leftover straw and husk in their fields to prepare for the winter wheat crop. In 2024, peak days saw over 1,500 farm fires in a single day, with stubble burning contributing to as much as 15-21% of Delhi’s PM2.5 levels during high burning periods. On such days, Delhi’s Air Quality Index (AQI) frequently exceeds 300, categorizing it as “Very Poor” or even “Severe,” posing serious health risks to the population.

Agricultural Shifts and Compressed Crop Timelines

Over the last decade, several key developments in agriculture have altered the timing and intensity of stubble burning:

Modern Harvesting Equipment: The widespread use of combine harvesters has sped up rice harvesting and increased stubble residue. Since harvesters cut crops higher off the ground than manual methods, they leave behind more straw.

With limited time for natural decomposition, burning becomes a practical, though harmful, solution for many farmers.

Fertilizer-Intensive Crops: Fertilizer usage has contributed to quicker-growing crops with denser and more fibrous residue, which complicates residue management. The Green Revolution, aimed at boosting rice production, has had unintended consequences, creating larger volumes of crop residue that are difficult to manage sustainably.

Water Conservation Policies: To protect groundwater levels, especially in Punjab, the government mandates that rice planting not start until the monsoon arrives in mid-June. As a result, rice harvesting now aligns with late October, which forces farmers to quickly prepare their fields for the wheat season, often resorting to burning stubble. This compressed timeline has aligned stubble burning with the onset of winter, when weather conditions trap pollutants close to the ground, worsening smog conditions in Delhi.

Temperature Inversions and Seasonal Weather Patterns

In late autumn, temperature inversions—a meteorological condition where a layer of warm air traps cooler air below—are common in northern India. This "lid" effect prevents pollutants from dispersing upwards, concentrating pollution at ground level. As the temperature drops and humidity increases, the trapped pollutants combine with fog, creating thick, hazardous smog that lasts for days or weeks.

Increased Vehicular and Industrial Emissions

Delhi's high population and its role as an economic hub lead to substantial vehicle emissions, which contribute to PM2.5 and PM10 pollution. Although cleaner fuel policies have been introduced, the increase in vehicle numbers over the last decade has largely offset these gains. Industrial and construction dust also add significant pollutants to the atmosphere, making Delhi's air more toxic during this season.

Diwali Fireworks

The Hindu festival of Diwali, typically in October or November, brings a spike in firework use, which releases large amounts of particulate matter into the air. While regulations have attempted to limit this practice, it often coincides with the peak stubble-burning period, creating an additional pollution surge.

Timeline of Delhi's Smog Crisis

Late September to Early October

Stubble burning begins in Punjab and Haryana as early harvests conclude. While some early burning occurs, the weather in Delhi remains relatively mild, keeping AQI levels within moderate limits.

Mid-October to Early November

This period sees a steep increase in stubble burning incidents, often exceeding 1,000 farm fires per day. During peak burning, stubble contribution to Delhi's PM2.5 levels reaches as high as 20%, and AQI levels surpass 300, placing Delhi in the "Very Poor" category. Diwali-related fireworks further exacerbate pollution levels during this time.

Late November to Early December

Although stubble burning decreases, winter weather conditions trap pollutants, and high pollution levels persist due to local emissions from vehicles, industries, and construction. Smog lingers until strong winds or rain arrive, providing relief by dispersing the pollutants.

Conclusion

Delhi's smog crisis each autumn has worsened considerably due to changes in agricultural practices and compressed crop cycles that align stubble burning with peak winter inversion periods. Combined with increased vehicle numbers and urban pollution sources, Delhi's air quality degrades every year in October and November. Solutions to this crisis needs collaborative efforts across states to manage crop residue sustainably, vehicular emissions regulations, and urban planning adjustments. Until these solutions are fully realized, Delhi's air quality during the late autumn period will remain a significant public health concern, impacting millions of residents annually.

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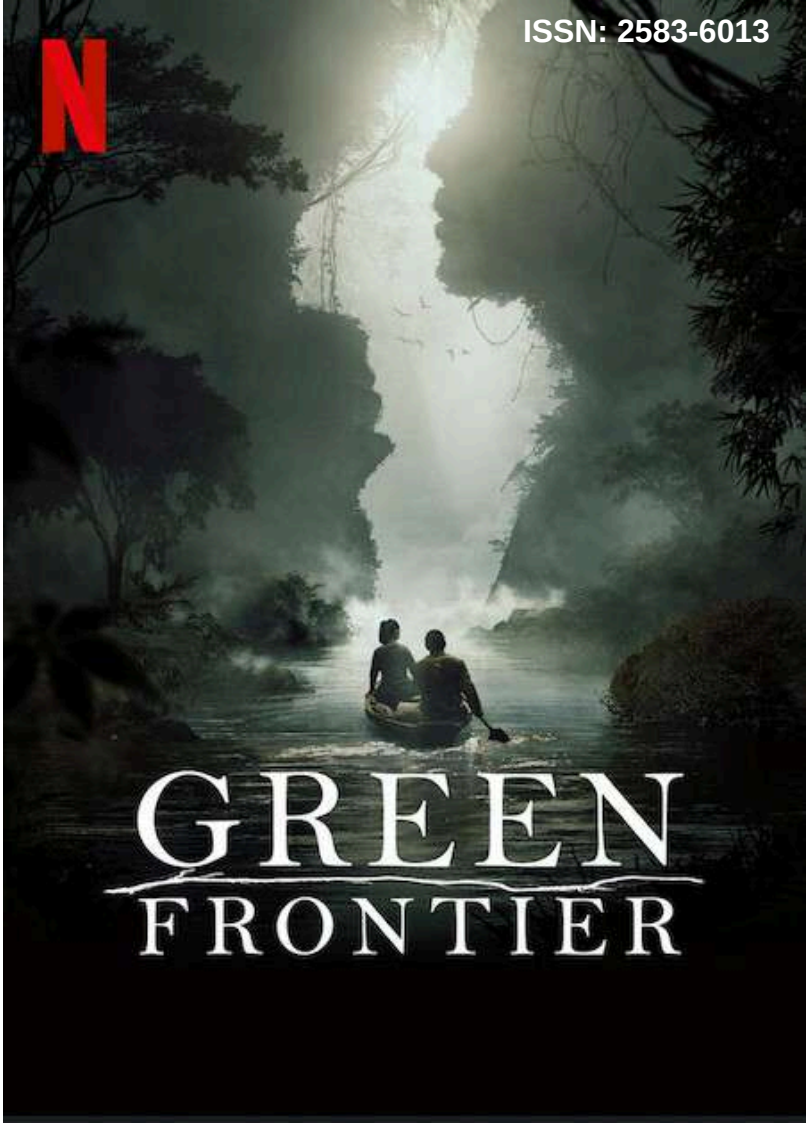
MOVIE RECOMMENDATION

GREEN FRONTIER (2019)



Green Frontier (Spanish: Frontera Verde) is a supernatural thriller series from Colombia, produced by Netflix. Set in the depths of the Amazon rainforest, the series follows Detective Helena Poveda as she investigates a series of mysterious murders on the border between Colombia and Brazil. As she delves deeper, Helena uncovers secrets about her own past and encounters indigenous tribes who guard ancient, mystical knowledge. Blending crime, magic, and elements of environmental and cultural themes, *Green Frontier* offers a haunting exploration of the clash between modernity and ancient wisdom in the heart of the jungle.

PLOT SYNOPSIS

In *Green Frontier* (*Frontera Verde*), detective Helena Poveda from Bogotá is dispatched to a remote region in the Amazon rainforest, on the border between Colombia and Brazil, to investigate the brutal murders of several young women. The case takes a strange turn when she discovers that one of the victims, identified as Yua, shows no signs of decay despite being dead for days. As Helena begins to investigate, she finds herself plunged into an otherworldly world full of ancient secrets and mysticism that she never imagined.

Helena soon meets a local indigenous tribe deeply connected to the mysteries of the jungle. Led by Ushe, a shaman with unique powers, the tribe warns Helena about an ominous, dark force present in the forest. She learns about "The Eternal," a clandestine cult led by a powerful group of outsiders who seek to harness the Amazon's mystical properties to achieve immortality. This cult's practices threaten the sacred balance of the rainforest, leaving a trail of destruction and death in their pursuit.

As Helena digs deeper, she uncovers a hidden connection between herself and the indigenous people, revealing mysteries about her past and her family's roots that she had never known. Caught between the supernatural and reality, she must confront her own beliefs and wrestle with the jungle's spiritual forces while tracking down the cult responsible for the killings. Her journey becomes not just a murder investigation but a quest to protect an ancient way of life threatened by greed and exploitation.

Through its haunting narrative and stunning jungle landscapes, *Green Frontier* explores themes of environmental preservation, the clash between indigenous wisdom and modern encroachment, and the spiritual depth of the Amazon. As Helena faces unimaginable threats, she learns that saving the forest might also mean discovering her true purpose and heritage in the process.

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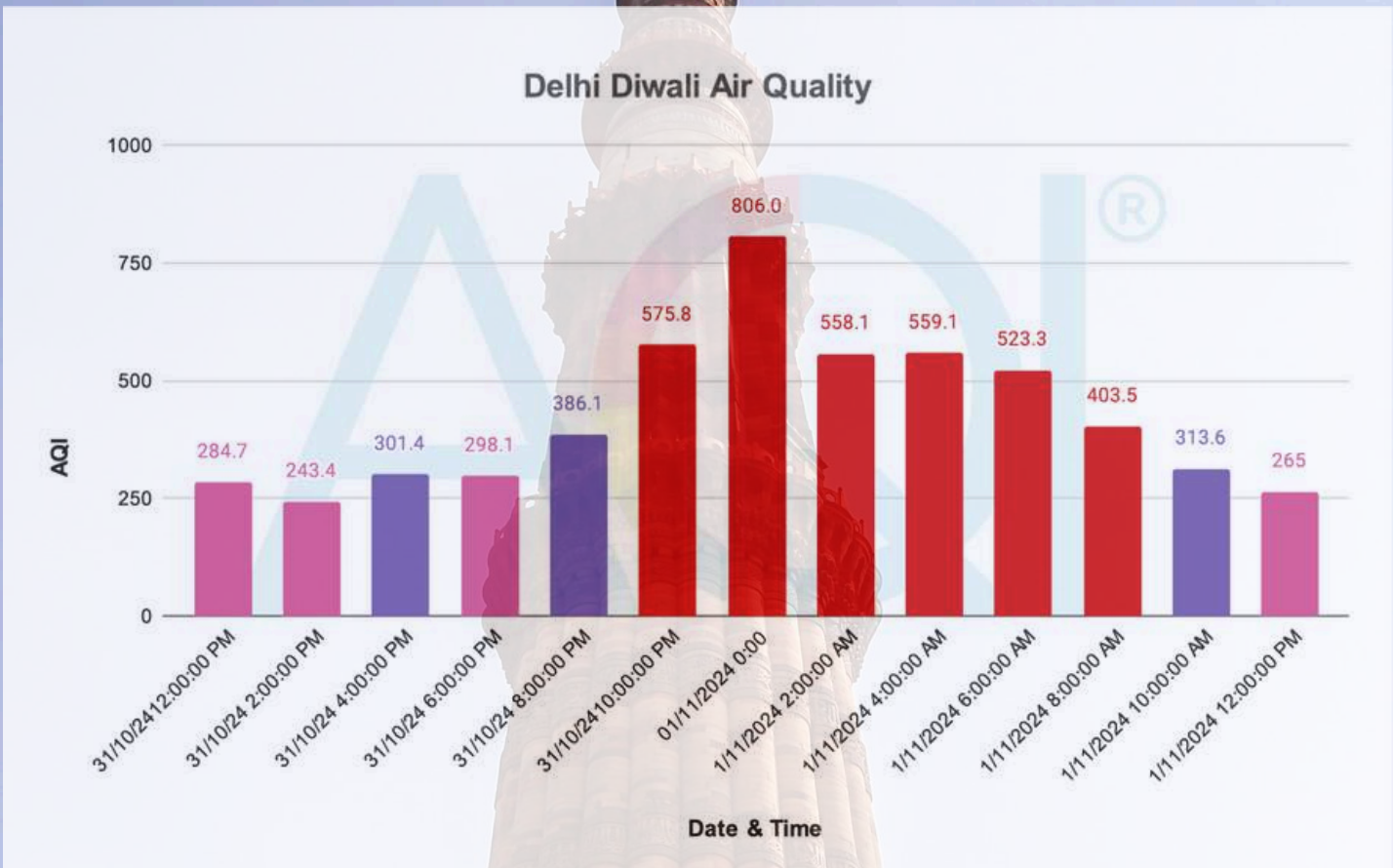

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