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DEVELOPMENT ALTERNATIVES

Monthly newsletter on issues of sustainable development

Green brick molding in action by a brick kiln worker in Bihar

Tackling Carbon Emissions for a Greener Future

Contents

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Reducing Carbon Emissions with Green Technologies

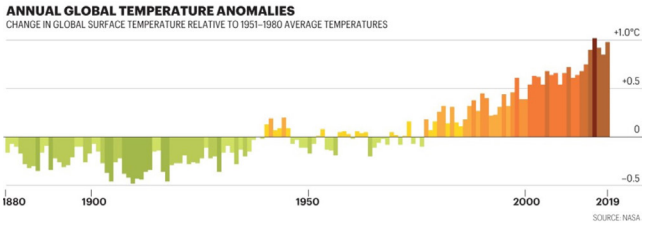
The past five years have been the warmest ever for the world, a stark reminder of the urgent need for climate action. The intensifying heat directly results from rising greenhouse gas emissions, which are driving climate change and its devastating impacts. These include more frequent and severe weather events, rising sea levels, and disruptions to ecosystems and livelihoods. The urgency to address these issues is underscored by the fact that global temperatures could rise beyond 3 °Celsius this century without immediate action, exacerbating the challenges faced by vulnerable populations worldwide.

Today, academic research underscores the potential of green technologies in reducing carbon emissions and mitigating the worst effects of climate change. Rising carbon emissions and temperatures are projected to have profound consequences on the global economy. Achieving net-zero emissions is crucial for a sustainable future. This necessitates a coordinated global effort to transition to green technologies, including renewable energy sources, improving energy efficiency, and implementing sustainable technological practices across all sectors.

The Development Alternatives Group plays a pivotal role in addressing the global challenge of climate change. It mandates the use of various technologies and innovative approaches being developed and implemented to reduce carbon emissions. In this issue, the authors have reviewed and discussed some unique technologies and perspectives for reducing carbon emissions.

Traditional brick-making processes are energy-intensive and contribute significantly to carbon emissions. Non-fired brick-making technology offers a sustainable alternative: using geopolymer binders and construction waste to produce bricks without the need for high-temperature kilns. This method reduces emissions and repurposes waste materials, contributing to a circular economy. In Bihar, the innovative use of pond ash—a byproduct of coal combustion—has shown promise in sustainable brickmaking. By incorporating pond ash into the brick-making process, local manufacturers can reduce the reliance on traditional clay and minimise carbon emissions. This approach addresses waste management issues and supports local economies by providing a cost-effective building material.

The other side of the spectrum covers artificial intelligence (AI), revolutionising how we approach



Variation in global surface temperatures indicating the effects of increasing carbon emissions

carbon emission reduction. AI-based decision support systems can optimise energy use, forecast renewable energy production, and manage smart grids. By analysing vast amounts of data, AI can provide actionable insights for improving energy efficiency and reducing emissions across various sectors. Heavy industry, aviation, and shipping sectors are notoriously difficult to decarbonise due to their reliance on high-energy processes and fossil fuels. Significant investments in climate finance are needed to develop and deploy technologies like carbon capture, utilisation, and storage (CCUS), hydrogen-based fuels, and advanced bioenergy. These investments are crucial for achieving emission targets and transitioning to a low-carbon economy.

The transition to a low-carbon future requires a multi-faceted approach, combining technological innovation with supportive policies and societal changes. The urgency of these policies cannot be overstated. Governments, industries, and individuals all have roles to play in this transition. By investing in and adopting these technologies, we can move closer to a sustainable and carbon-neutral future.

The call for innovations in green technologies has never been more imminent. This includes advancements in other key areas, such as clean energy production, storage, and sustainable manufacturing processes. Green technology innovation will help growing populations reduce resource consumption and emissions during production, contributing to a more sustainable economy. ❐

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Building Blocks for Sustainable Construction: Non-Fired Brick-Making Technology

Freshly baked red bricks ready to build a green future

India has one of the largest construction industries in the world and it heavily relies on the brick kiln industry. With over 500,000 brick kilns scattered across the country, the traditional clay brick industry plays a pivotal role in providing essential building materials. This sector faces social and environmental challenges, highlighting the urgent need for a shift towards more sustainable construction practices. Non-fired brick-making technology emerges as a promising solution.

Traditional Brick Kilns

Traditional brick kilns have a significant environmental impact as they contribute substantially to air pollution by emitting large quantities of particulate matter (PM), black carbon, sulphur dioxide (SO_2), and nitrogen oxides (NO_x). These pollutants degrade the air quality and pose severe health risks to the people living nearby. The widespread use of coal as a fuel source in these kilns also results in significant greenhouse gas emissions, primarily CO_2, which results in global warming.

Another issue associated with traditional brick kilns is land degradation. The extraction of clay for brick production often leads to the loss of fertile topsoil and soil erosion, resulting in vast tracts of land becoming barren. This unsustainable practice not only depletes natural resources but also undermines agricultural productivity.

The Social Cost of Brick Production

The brick kiln industry heavily relies on an informal workforce working under harsh conditions, often enduring long hours, low wages, and inadequate safety measures. This includes women and children, who are subjected to exploitative practices such as bonded labour in some regions. It is urgent to reform this sector to address these issues.

Transitioning to cleaner, more sustainable technologies, such as non-fired brick-making, is a critical need to tackle the environmental and social challenges, associated with traditional brick production.

Non-Fired Brick Making: A Sustainable Alternative

Non-fired bricks represent a significant step towards sustainable construction. Unlike traditional bricks that require high-temperature firing, non-fired bricks are produced without the need for combustion, drastically reducing greenhouse gas emissions. This technology not only conserves energy but also minimises the depletion of natural resources such as clay.

One of the primary goals of non-fired brick production is to test the suitability of

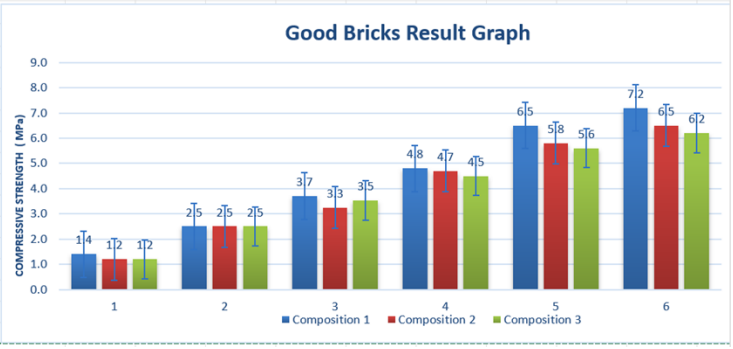
Construction of a house with red bricks

Difference of quality between good bricks and locally made bricks

Good brick various Composition test results

Test results

Sl.	Test parameters	Composition to be used 1	2	3
1	Composition %			
	Soil	90	91	92
	cement	9.8	8.8	7.8
	Soil stabilizer	0.2	0.2	0.2
2	Compressive strength (MPa)			
	1 day	1.4	1.2	1.2
	3 day	2.5	2.5	2.5
	7 day	3.7	3.3	3.5
	14 day	4.8	4.7	4.5
	21 day	6.5	5.8	5.6
	28 day	7.2	6.5	6.2



Comprehensive strength test results of good bricks made with daily soil

various Indian soils for making durable and high-quality bricks. By experimenting with different soil compositions, such as red soil, yellow soil, black soil, agricultural soil, and Indo-Gangetic soil, researchers aim to identify the most effective mixtures for brick production. Typically, these mixtures consist of 90% soil, 9.8% cement, and 0.2% stabiliser.

Additionally, non-fired brick technology emphasises the use of waste materials, such as legacy ash from thermal power plants and sandstone dust, in brick production. By utilising waste, this method not only reduces the demand for virgin raw materials but also addresses the environmental burden of waste disposal. Incorporating these materials into brick production aligns with the overarching objectives of sustainable development, promoting resource efficiency and waste minimisation.

Optimising Cement and Stabiliser

Optimising the use of cement and stabilisers to reduce costs without sacrificing the strength and durability of bricks is a crucial component of non-fired brick-making technology. By adjusting the cement and stabiliser content, brickmakers can produce economically and ecologically sustainable bricks. This optimisation not only increases profitability but also contributes to a more sustainable building sector overall.

Conclusion

The transition to non-fired brick-making technology represents a significant step towards a more sustainable construction industry. This innovative technology offers a cleaner, more efficient, and socially responsible alternative that addresses the burning issues of the environment and society. Embracing non-fired bricks is not just about reducing carbon emissions or conserving resources; it is about building a future where sustainable development is central to the construction industry. ❐

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Investments for 'Hard-to-Abate Sector' to Meet Emission Targets

Organisations and industries need to function smoothly for a sustainable future

Hard-to-abate industries are sectors with high carbon emissions that are challenging to reduce due to various factors, including economic, technical, practical, or the very nature of the industry. These industries are crucial to economies and essential to modern life. However, they are difficult to decarbonise using current carbon reduction technologies and methods. The most practical solution to this major issue is improvising the existing CCUS (carbon capture, utilisation, and storage) and maximising its efficiency.

Some existing industries considered hard-to-abate include cement, steel, chemical, oil and gas extraction, heavy transportation and machinery, and industries requiring high-temperature processes.

Governments around the world and international governing organisations are establishing ambitious targets to reduce carbon emissions in the coming decades to address anthropogenic-caused environmental degradation. Achieving these targets will require multifaceted investments and efforts tailored to the specific needs of every individual industry and organisation. Many hard-to-abate sectors are essential for economies but require substantial investment. Some strategies that can help mobilise investments towards these industries are as follows:

1. **Government policies:** Increasing the actual prices of carbon pricing mechanisms can improve the economic and financial attractiveness of these industries. Implementing regulatory frameworks can also be introduced to provide long-term stability for these industries, their investors, and, most importantly, the environment. Tax credits, grants, and subsidies can be given to these sectors to incentivise investments in low-carbon technologies.

Emissions ideally need to be offset at source

2. **ESG (Environmental, Social and Governance) and CSR (Corporate Social Responsibility):** The efforts made by organisations to lower their carbon footprint immensely help them, improving their goodwill with the government and public in the long run. These companies need to understand the dire need of the hour to work towards environmental degradation. If every organisation involved makes sincere efforts, significant progress can be made over the next decade. This is profitable to the organisation itself because it helps them maintain smooth functioning with the government, as well as public investments in the long run.
3. **Research and development:** Educational institutions, think tanks, multinational organisations, researchers, and industry experts can collaborate to develop innovative technologies and create new low-carbon pathways customised for specific industries according to their needs. This can involve the development of CCUS, high-temperature electric heating, and the optimisation of circular economies among multiple relevant organisations, etc.
4. **Finance mechanisms:** Green and sustainable bonds are designed to finance projects that have environmental benefits. Many banks and financial institutions are engaged internationally in providing these bonds to institutions that are willing to contribute to low-carbon development. Blended finance, a combination of capital from private and public sources, can also be used to minimise the adverse impacts of failures.
5. **Technological validation:** The success of low-carbon efforts relies on the reliability of the technology and its ability to instill confidence in investors. Adherence to international standards and certification schemes, such as ISO certifications, needs to be followed to enhance the market credibility of low-carbon technologies.

Overall, low-carbon efforts are the need of the hour and need to be worked upon by industries as well as governments. Some areas where procured investments can be directed are technology development and innovation, policy and infrastructural support such as carbon pricing mechanisms, research and development, improving efficiency and circular economy, as well as international collaboration and cooperation. ❐

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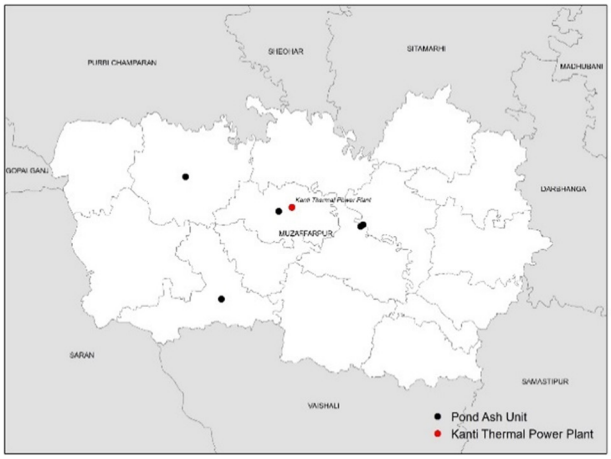
Utilisation of Pond Ash in Brick Making

Pond ash bricks fresh out of the kiln

Pond ash is a byproduct of coal-fired thermal power plants, and it has immense potential for making fly ash brickmaking, which contributes significantly to both sustainability and waste management. It contains a notable amount of fly ash, and when combined with sand, stone dust, and cement, it serves as a sustainable alternative to red clay bricks. This helps to mitigate coal combustion and soil degradation occurring at a faster rate owing to rapid urbanisation and uptake in the demand for real estate. The utilisation of pond ash addresses a circular economy, where industrial waste is transformed into productive and valuable construction materials.

Our Work

A survey conducted by the Development Alternatives team in the Muzaffarpur district of Bihar aimed to understand the impact and potential of utilising ponded ash. The district



Pond ash units in Muzzafarpur district, Bihar

is strategically located in the northern part of Bihar, near neighbouring countries like Nepal and Bhutan. This facilitates the expansion of its market reach for building materials, as well as accessibility of roads and railways. Availability of pond ash from NTPC Kanti and the state government's emphasis on infrastructure

development and economic growth enables the setting of ponded ash enterprises in the district. A quality audit was conducted on the fly ash bricks of several companies, following the guidelines of the Bureau of Indian Standards (BIS) and the Fly Ash Bricks Quality Rating System (FABQRS). The quality assessment revealed distinctive properties in terms of metallic sound, showcasing structural integrity and uniformity in composition, smooth and even surface, with well-defined corners, demonstrating production accuracy. The curing process was very effective, taking only about a week to reach the optimal levels of strength and durability. The expedited curing time improves production efficiency and availability of bricks for construction. The raw materials used in the production process near Muzaffarpur are pond ash, cement, stone dust, and water. Due to the unavailability of lime, cement is primarily used as the binder for brickmaking.

DA conducting field inspection

Impact of Pond Ash Brick Making

The utilisation of pond ash in brickmaking offers many benefits in terms of environmental, economic and structural aspects. From an environmental perspective, pond ash reduces carbon emissions by decreasing clay bricks, cement, and coal combustion, all of which are associated with significant greenhouse gas emissions. It also helps in reducing soil degradation by conserving topsoil. Pond ash bricks offer structural advantages such as superior quality compared to conventional clay bricks, dimensional accuracy, and uniformity in size, which enhances construction quality. These bricks are fire resistant and lighter in weight, reducing the overall load on structures. Additionally, the

Dr Soumen Maity conducting a field survey in Muzzafarpur

brick-making process harbours year-round employment opportunities, countering seasonal employment, and helps transition labourers from labour intensive to mechanised processes, improving their working conditions and offering higher remuneration while diminishing their exposure to harmful suspended particles and gases experienced in clay brick kilns.

The ponded ash industry in Muzaffarpur, Bihar, faces several challenges. These challenges can be addressed by streamlining procurement processes, addressing the pricing disparities faced by the entrepreneurs, and ensuring fair allocation of fly ash by the thermal power plants. Additionally, fostering demand, improving quality assurance, offering benefits, and advancing efficient government support will be crucial. Implementing training, certification, and mandating usage near NTPC plants will promote sustainable practices. The utilisation of pond ash in brick making, particularly in regions like Muzaffarpur, showcases ample opportunities for entrepreneurs and favourable outcomes spanning environmental, structural, and economic considerations, thus significantly fostering sustainable development. ❐

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Use of Artificial Intelligence as Decision Support System

The advancements in technologies like GeoAI is helping combat pollution caused by traditional brick kilns

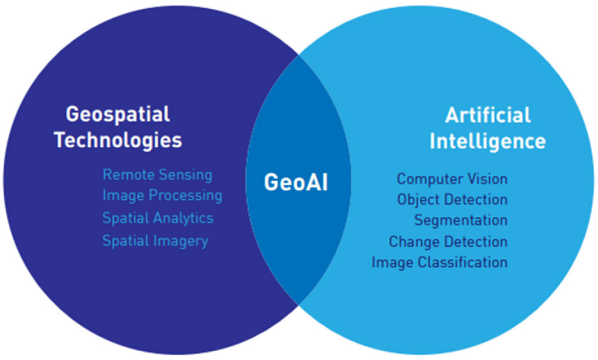
During the first Italian campaign, Napolean said, 'The hand that gives is above the hand that takes' to emphasise the position of power held by the giver over the receiver. This statement has stood the test of time and has become an undesirable reality today, evident in the struggles of workers in the economy.

India is the world's second-largest brick producer. Approximately 10 million to 23 million people migrate yearly to work in the 144,000 brick kilns operating across the country (Kamayotra, 2015). Despite being an unorganised sector, it employs around 8 million people each season, constituting roughly 0.7% of the nation's gross domestic product (Maithel et al., 2019). With the rise of the real estate market, this industry is expanding. It is a highly labour-intensive enterprise. According to a World Bank report, in 2020, the demand for bricks grew by 7%-10% annually due to economic growth in India, the world's second-largest brick producer.

There are several challenges plaguing the brick industry in India. As a substantial contributor to climate change, it has disastrous environmental consequences that affect billions of people. Kiln employees, their families, and the surrounding communities suffer irreparable harm to their health and well-being through respiratory and cardiovascular diseases. The brick production industry is an epicentre of vulnerabilities, frequently operating outside regulatory oversight, with government departments often unaware of the number of kilns in operation within their jurisdictions.

GeoAI Architecture and Technology

GeoAI technology has emerged as a novel approach, an amalgamation of artificial intelligence and geospatial technologies to identify satellite imagery. GeoAI platform developed by UNDP and Rights Lab at the University of Nottingham is providing insights into the locations of more than 47,000 brick kilns along Indo-Gangetic plains with 96% accuracy in India. It also involves digital volunteering and citizen science components to generate training data sets for machine learning algorithms. In the context of brick kilns, this technology generates value-added insights such as the degree of compliance



GeoAI specifications

to environmental criteria, technology classification, Fixed Chimney Bull Trench Brick Kiln (FCBTK), or Zigzag. It also aids in monitoring emissions, optimising fuel consumption, and creating spatial mapping of brick kiln locations, assisting the government departments to employ the interventions, such as regions with high concentrations of kilns contributing to severe air pollution. For instance, GeoAI has identified 7,845 brick kilns across Bihar, far exceeding previous estimates with the Bihar State Pollution Control Board (BSPCB) official records of 6000 kilns.

Our Work

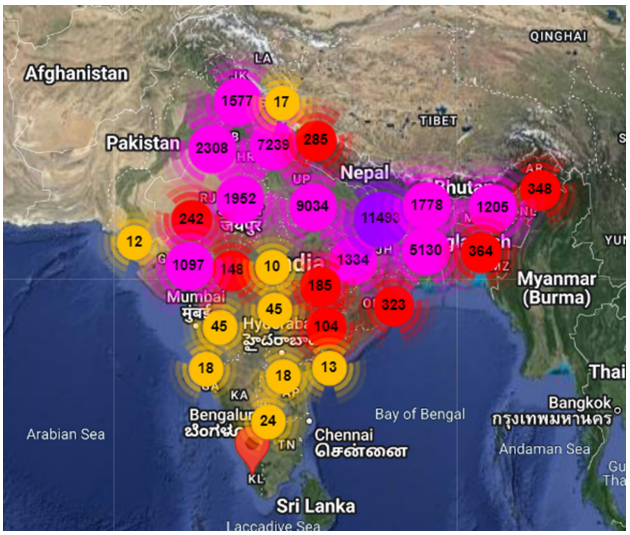
Development Alternatives has leveraged GeoAI technology in four Indian geographies: Bihar, Chhattisgarh, Odisha, and Uttar Pradesh. It is piloting a livelihood module and environmental inspectorate in these states, utilising its ground-level expertise in primary data collection and field inspection.

Our objective is to transform the Indian brick kiln sector by bringing about positive changes in technology, workforce welfare, and policy implementation.

- We aim to modernise brick kiln technology by quantifying them through a GeoAI app, shifting FCBTK kilns to more efficient zig zag kilns.
- Additionally, we seek to bring positive changes in the lives of brick kiln workers by increasing their accessibility to social sector schemes of the state and at the national level. Often, they are unaware of their existence; mostly, they are interstate migrants accompanying their families.
- Finally, we aspire to assist in establishing efficient policies and regulations at the state level regarding brick sector regulation and promotion.

A brick kiln in Bihar

The primary focus of these objectives encompasses several key aspects, each of which has undergone in-depth analysis by bringing coordinated actions from various stakeholders in these states, including the BSPCB, the Labour Resource Department of Bihar, the Labour Department of Chhattisgarh, the Odisha State Pollution Control Board, Brick Kiln Associations, and various civil society members, to tackle the complexity. This involves conducting field inspections and gathering real-time data on the ground. These data feed back into the Geo AI algorithms, which tend to generate value-added insights and further improve its accuracy. The GeoAI initiative highlights a practical approach to bridge the evidence gap between the brick kiln census and the informal economy. We could efficiently address the evidence gap by leveraging artificial intelligence, remote sensing, and collaborative digital platforms. ❐



GeoAI technology providing real-time insights into brick kiln locations

End Notes

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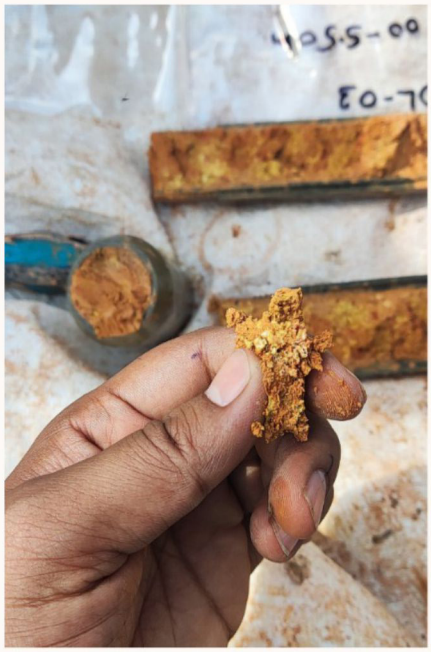
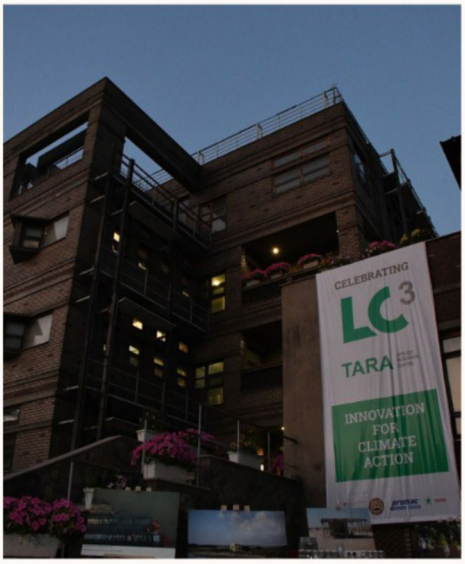
Limestone Calcined Clay Cement (LC$^{3®}$)

A sustainable solution to the growing demand of the cement industry





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