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ENHANCED ROCK WEATHERING (ERW) FUELS NEW CARBON OPPORTUNITIES IN INDIA

-Dr. Vivek Panwar,
Assistant Professor, Sri Venkateswara College,
University of Delhi

Enhanced Rock Weathering (ERW) is rapidly emerging as one of the most promising nature-based carbon dioxide removal (CDR) strategies in the fight against climate change. By accelerating the natural process of silicate mineral weathering, ERW captures atmospheric CO_2 and converts it into stable bicarbonates, which are eventually transported to the oceans, offering long-term, measurable carbon sequestration benefits. Yet beyond just locking away carbon, ERW provides critical ecological and agricultural co-benefits improving soil structure, enhancing fertility, and restoring degraded landscapes, making it uniquely positioned for dual wins in both climate mitigation and rural development.

India, with its vast basaltic landscapes of the Deccan Plateau and rich reserves of ultramafic rocks like olivine and serpentine scattered across states like Odisha, Jharkhand, and parts of the Northeast, holds immense potential for deploying ERW at meaningful scale. These rock types, abundant in magnesium and calcium silicates, react efficiently with atmospheric CO_2 in the presence of water and soil acidity, forming carbonates and bicarbonates. This mineral carbonation process not only traps carbon but also releases essential nutrients such as magnesium, calcium, potassium, and trace elements, improving soil health and boosting crop productivity.

Integrating finely crushed rock application into existing agricultural systems, particularly in rain-fed and marginal lands, could offer a cost-effective and scalable pathway to enhance food security while simultaneously drawing down carbon from the atmosphere. Small and marginal farmers could gain from improved soil pH, increased water retention, enhanced crop yields, and reduced reliance on chemical fertilizers. In this sense, ERW elegantly aligns with India's push towards climate-smart agriculture, soil health missions, and the Pradhan Mantri Krishi Sinchai Yojana (PMKSY) aimed at improving farm productivity through sustainable interventions.

The global carbon market is increasingly shifting focus from conventional emission reduction

projects to verifiable, durable carbon removals, and ERW fits well into this evolving narrative. With international frameworks like Article 6 of the Paris Agreement and rapidly growing voluntary carbon markets demanding high-integrity removal projects, ERW offers a natural fit for India's emerging climate finance strategy. By establishing scientifically robust pilot projects and standardized protocols for quantifying carbon sequestration through soil sampling, mineral dissolution rate measurements, carbon accounting models, and life cycle assessments (LCA) India could position itself as a credible supplier of high-quality carbon credits.

This presents a timely opportunity for India to not only meet its ambitious net-zero target by 2070 but also to access new avenues of climate finance, strengthen its carbon credit inventory, and support rural green livelihoods. The co-benefits extend far beyond carbon. ERW can combat soil degradation, enhance land productivity, replenish micronutrients in nutrient-depleted soils, and even aid in combating desertification in vulnerable arid regions of Rajasthan, Gujarat, and parts of Telangana.

Incorporating ERW into national afforestation and land restoration programs such as the Green India Mission and the National Mission for a Green India could amplify its impact, combining carbon drawdown with ecosystem restoration. Additionally, it can be integrated into employment guarantee schemes like MGNREGA, creating rural jobs in quarrying, crushing, transporting, and applying crushed rocks to fields further strengthening rural economies while addressing environmental challenges.

On the technological front, the declining cost of remote sensing, geochemical monitoring tools, and digital MRV (Monitoring, Reporting, and Verification) systems is making it increasingly feasible to track ERW's impact with greater precision and affordability. Collaborations with research institutions, universities, and technology startups can help develop predictive models and site selection tools, ensuring that ERW applications are optimized for local soil types, rainfall patterns, and cropping systems.

Globally, Enhanced Rock Weathering is gaining momentum. Countries like the UK, USA, Australia, and Brazil have launched pilot programs, with private sector players and agri-tech startups actively exploring its commercial viability. India, given its geological resources, agriculture-dependent economy, and commitment to climate leadership, is well-placed to emerge as a pioneer in this field within the Global South.

Yet challenges remain. Awareness among farmers, initial logistical costs, and public policy clarity on CDR pathways will need to be addressed. It's essential for policymakers to develop incentive structures, perhaps through carbon farming subsidies, carbon credit pre-purchase agreements, or climate-resilient agriculture funds, to make ERW adoption attractive and economically viable for farmers.

As climate pressures mount and hard-to-abate sectors like cement, steel, and heavy industry look to offset residual emissions, India's potential to supply nature-based, scientifically credible carbon removals through ERW could prove invaluable. It's not just a climate solution — it's a green economic opportunity, a pathway to healthier soils, sustainable farming, rural job creation, and an equitable transition for communities most vulnerable to climate change.

Going forward, multi-stakeholder partnerships involving state governments, research institutions, carbon market experts, industry leaders, and farming cooperatives will be critical to develop pilot demonstrations, establish robust MRV frameworks, and create scalable business models. With strategic policy backing and climate finance alignment, Enhanced Rock Weathering could be a cornerstone of India's next-generation climate strategy, setting a global example of how nature-based solutions can be deployed at scale in developing economies.

It is time to turn this geological asset into a climate ally, unlocking a new chapter in India's carbon removal and sustainable development journey.