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Climate Finance, Carbon Markets and Environmental Justice in Pakistan

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	Abstract
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Keywords	Market-based mechanisms; political ecology; carbon markets; climate finance; green bonds; REDD+; environmental justice; Pakistan

1. Introduction

Climate change has moved, over the past two decades, from a specialist scientific concern to a matter states are legally bound to address. The Kyoto Protocol required industrialised countries to cut emissions by 5.2% below 1990 levels; the Paris Agreement replaced binding targets with nationally determined contributions submitted by every signatory (Elkerbout, 2020; Sharma et al., 2020). Between these two agreements, a particular policy instrument gained prominence: market-based mechanisms (MBMs), which use economic incentives rather than fixed regulatory limits to reduce greenhouse gas emissions (Dudek et al., 2014). Proponents argue MBMs create carbon markets that reward efficient emissions reduction and generate revenue for further mitigation (Stavins, 2022; Aldy, 2010). Critics counter that MBMs rest on the assumption that economic growth can continue indefinitely without ecological cost, and that they displace rather than resolve the underlying drivers of environmental degradation (Hansen, 2010; Parks & Roberts, 2013).

Pakistan has adopted MBMs on both fronts of this debate. Carbon offset projects operate in the Kasur and Jhimpir districts; a USD 500 million green bond was issued in 2017 to fund renewable energy and efficiency projects; debt-for-nature swaps have been negotiated to redirect debt-service payments toward environmental initiatives; REDD+ programming operates in partnership with the World Bank and the Food and Agriculture Organization; and payment-for-ecosystem-services schemes operate in areas such as the Cholistan desert (Ali, 2019; Climate Bond Initiative, 2021). The country's exposure to climate risk gives these instruments practical urgency: Pakistan is routinely ranked among the countries most vulnerable to climate change despite its comparatively small contribution to global emissions, and its agriculture-dependent economy, exposed to floods, glacial melt and water scarcity, has limited capacity to absorb repeated shocks (Hussain & Mumtaz, 2014; Arif et al., 2019).

Whether these instruments deliver on their stated purpose is contested. Some studies find MBMs generate meaningful revenue and measurable emissions reductions; others find they exacerbate inequality by locating projects in areas where local communities have little say in how they are designed or who benefits (Bumpus & Liverman, 2008). Political ecology offers a way to hold both possibilities in view at once: rather than asking only whether an instrument reduces emissions, it asks who gains control over resources and revenue as a result, and at whose expense. This study applies that lens to four MBMs operating in Pakistan, green bonds, debt-for-nature swaps, REDD+, and PES, treating them not as a single undifferentiated category but as four distinct arrangements whose common patterns, and points of divergence, only become visible when examined together.

1.1 Research questions and objectives

Three questions guide the study: how successful have market-based mechanisms been in reducing Pakistan's exposure to climate change; what does political ecology theory add to understanding the consequences of using these mechanisms; and what core challenges and limitations constrain their use in the Pakistani context. The corresponding objectives are to analyse the efficacy of MBMs operating in Pakistan, to apply political ecology theory to interpret their impact, and to identify the obstacles that limit their effectiveness.

1.2 Significance and research gap

Existing literature analysing MBMs through a political ecology lens has concentrated on cases in Kenya, Nepal and other specific national settings (Goulet et al., 2015; Luintel et al., 2018); comparatively little work applies that framework systematically to Pakistan, where four distinct mechanisms already operate side by side. Most Pakistan-focused studies instead evaluate individual instruments, carbon trading potential, renewable energy financing gaps, in isolation from the political and institutional context that determines whether their benefits reach the communities most exposed to climate risk (Lin & Ahmad, 2017; Ahmed et al., 2020). This study addresses that gap directly, and its relevance extends beyond the immediate case: the constraints identified here, weak regulatory oversight, limited access to implementation technology, and the risk of deepening existing social inequality, recur across developing economies attempting to finance climate action through market instruments.

2. Literature Review

2.1 Market-based mechanisms: global architecture

The Kyoto Protocol established three mechanisms intended to lower the cost of achieving emissions targets: emissions trading, joint implementation, and the Clean Development Mechanism (CDM) (Tang et al., 2020; Monast, 2016). Between 2005 and 2019, over 7,700 CDM projects were registered, more than half of them in China and India, and roughly 75% concentrated in the energy sector (UNFCCC, 2019). Carbon prices under these schemes have fluctuated sharply: from USD 25–35 per tonne at the 2008 peak of EU ETS demand, down to roughly USD 2 per tonne after the 2008 financial crisis, before stabilising around USD 3 per tonne by 2018 (REDD+ Monitor, 2013; Donofrio et al., 2019). The Paris Agreement's Article 6 has since layered a new architecture on top of this system: Article 6.2 permits voluntary bilateral transfer of mitigation outcomes between countries; Article 6.4 establishes an internationally supervised mechanism functionally similar to the CDM; and Article 6.8 covers non-market approaches to mitigation and adaptation finance (UNFCCC, 2015; Philips, 2017).

Voluntary carbon markets operate alongside this compliance architecture, driven by private buyers rather than regulatory obligation. Multinational corporations purchased the largest share of voluntary offsets in 2017, at the lowest average price per tonne (Hamrick & Gallant, 2017), and land-use and forestry projects, including REDD+, have displaced renewable energy as the dominant category of voluntary-market volume since 2017 (Donofrio et al., 2019). This shift matters for the present study: it means REDD+ financing increasingly depends on a market where buyers can choose projects for reputational rather than verified environmental reasons, a dynamic with direct implications for how such projects are designed and who ultimately controls them (Vanderklift et al., 2019).

2.2 What determines whether MBMs work

Three sets of factors recur across the literature on MBM effectiveness. Social factors centre on public awareness: risk perception research finds that communities more conscious of climate risk are more supportive of mitigation policy, but that the slow, diffuse nature of climate change makes it difficult for that awareness to translate into sustained political pressure (Pelling, 2010; Aslam & Rana, 2022). Political factors concern the willingness and capacity of government to enforce environmental regulation against commercial interests that can, and often do, absorb or evade compliance costs, a dynamic well documented in industrialised economies but considerably harder to enforce in developing ones (Schmalensee & Stavins, 2019; Corsi et al., 2020). Economic factors concern the fiscal capacity of both firms and governments to absorb the cost of compliance: developing economies face the added constraint of weaker budgeting systems, which makes uniform, one-size-fits-all regulatory standards, of the kind associated with command-and-control policy, disproportionately costly for smaller firms (Ikram et al., 2021; Zafar & Mustafa, 2017).

Empirical findings on MBM outcomes diverge sharply depending on context. Goulet et al. (2015) find that carbon-offset projects in Kenya produced land capture, biodiversity loss and the displacement of Indigenous communities. Luintel et al. (2018), studying a Nepalese carbon-offset initiative, find the opposite: measurable gains in carbon sequestration and community benefit, attributed to a participatory project design that gave the local community an active role in decision-making. The difference between these two outcomes is not the mechanism itself but the governance arrangement surrounding it, precisely the variable political ecology is built to examine.

3. Theoretical Framework: Political Ecology

Political ecology treats environmental change as inseparable from the political and economic forces that shape it, rejecting the premise that ecological degradation can be explained by natural processes or individual behaviour alone (Robbins, 2019; Sikor & Lund, 2009). The field emerged in the 1980s from political economy, initially applied to resource-development programmes in the global South before extending to environmental governance in developed economies as well (Robbins, 2019). Its central move is to ask who holds power over environmental decisions, and how unequal access to that power produces unequal environmental outcomes (Büscher & Fletcher, 2015; Benjaminsen & Svarstad, 2021).

Applied to carbon markets specifically, political ecology has produced a sustained critique. Bakker (2015) argues carbon markets exemplify market environmentalism, a governance model that reproduces rather than corrects the imbalance of power between the global North and South; Nielsen (2016) and Obergassel et al. (2017) go further, describing this dynamic as a form of carbon colonisation in which offset projects, monoculture plantations among them, shift the burden of emissions reduction onto the same regions least responsible for causing the problem. Corbera and Brown (2010) extend this critique to the commercialisation of forest carbon specifically, arguing it deepens existing power asymmetries rather than resolving them. Goldman, Turner and Daly (2018) frame the Clean Development Mechanism as a governance experiment in which epistemic authority, who gets to define what counts as legitimate mitigation, and political authority operate together, often to the advantage of the same actors.

This study applies that framework to four MBMs operating in Pakistan: green bonds, debt-for-nature swaps, REDD+, and PES. Two elements of the framework do the analytical work in the sections that follow. First, the distinction between an instrument's stated technical purpose and its actual distributional effect, whether the entity capturing the benefit is the one bearing the cost. Second, the question of who participates in designing and governing a given mechanism, since political ecology treats participatory design not as a procedural nicety but as the variable that determines whether an MBM narrows or widens existing inequality (Cook et al., 2023; Streck, 2020).

4. Methodology

4.1 Research Design

A qualitative, descriptive research design was adopted, suited to developing a conceptual understanding of the interaction between social, political and economic factors shaping climate mitigation in Pakistan. Given that the research questions concern interpretation and power dynamics rather than measurable frequencies, a quantitative approach would not have generated the kind of evidence the study required.

4.2 Data Sources and Sampling

The study relies entirely on secondary data: government policy documents and publications, peer-reviewed journal articles, and reports from international financial institutions including the World Bank and the Asian Development Bank. Purposive sampling was used to select sources directly relevant to the four mechanisms under study, green bonds, debt-for-nature swaps, REDD+ and PES, and to the economic, governance and community-impact dimensions of each. Google Scholar, Web of Science, Scopus and JSTOR were searched using terms including "political ecology," "climate change" and "market-based mechanisms," supplemented by citation chaining from key sources.

4.3 Data Analysis

Content analysis was used to examine the collected material, a method suited to the secondary, document-based nature of the data (Bengtsson, 2016). Each source was read for its treatment of a mechanism's design, its stated beneficiaries, its documented outcomes, and any governance or equity concerns raised by the authors, then synthesised across sources to identify recurring patterns for each of the four mechanisms.

4.4 Ethical Considerations and Limitations

Every source used is cited, and the study was conducted with the aim of minimising interpretive bias in how findings across sources were synthesised. Three limitations follow directly from the study's design. It relies on the quality and availability of existing secondary data rather than original fieldwork, so gaps or biases in the underlying literature carry through into this study's findings. It uses content analysis rather than statistical methods, appropriate to the interpretive nature of the research questions but not suited to establishing causal or quantified claims. And because the study focuses specifically on Pakistan, its findings should not be generalised to other developing economies without independent verification, even where the mechanisms examined operate in similar form elsewhere.

5. Results

Content analysis of the four mechanisms produced a consistent pattern: each is technically capable of contributing to climate mitigation, and each has been constrained in practice by governance and equity problems specific to its design. The findings for each mechanism are presented in turn below.

5.1 Green Bonds

Green bonds function as conventional bonds earmarked for environmentally beneficial projects, and the global market for them grew from USD 10 billion in 2012 to USD 168 billion in 2017 (Maltais & Nykvist, 2020). The State Bank of Pakistan introduced a green banking framework in 2017, developed with the International Finance Corporation, requiring banks and development finance institutions to assess and manage climate-related financial risk (Mumtaz & Smith, 2019). Since most MBMs can only be legally exchanged between countries using the same mechanism, green-bond-financed projects remain heavily concentrated in developed economies, leaving developing countries such as Pakistan with comparatively limited access to this financing channel (Gulbrandsen & Andresen, 2004).

Within Pakistan specifically, two recurring constraints emerged. The first is a persistent gap in green human capital: research finds little emphasis on training staff to understand or implement green-finance instruments, with some studies reporting no significant relationship, and others a negative one, between green human capital investment and business sustainability outcomes (Malik et al., 2020; Jermisittiparsert, 2021). The second is affordability. Green products remain priced beyond what many Pakistani consumers can absorb, and government reforms intended to encourage green consumption have tended to be business-oriented rather than designed around consumer economic constraints, leaving a policy gap between what regulation demands and what the market can bear (Nawaz et al., 2021).

5.2 Debt-for-Nature Swaps

Debt-for-nature swaps allow indebted countries to redirect debt-service payments toward environmental initiatives instead of repaying creditors in foreign currency (Ayaz et al., 2022). In Pakistan, the mechanism's central constraint is institutional rather than financial: provincial ownership of environmental initiatives remains contested, undermining implementation even where federal-level agreement exists (Khan & Munira, 2021). The Ministry of Climate Change and the Ministry of Finance have, in practice, disagreed over the legitimacy of the market and the availability of resources for it, and this inter-ministerial gap compounds the provincial ownership problem rather than resolving it (Ahmed et al., 2020).

Weak public-sector capacity feeds back into creditor behaviour. Where a swap proceeds, creditors may treat it as evidence that a country cannot service standard debt obligations, an inference that can raise the cost of future borrowing (Asghar & Amjad, 2022). Scholars are divided on the mechanism's overall value: some note the equity exchanged in a typical swap is smaller than the debt it replaces, limiting its economic significance; others frame debt-for-nature swaps as a channel for advancing mutual interest between industrialised and developing economies, particularly where a country has other unmet investment needs (Ahmad et al., 2024; Jensen & Whitfield, 2022).

5.3 REDD+

REDD+ operates in Pakistan through the Ministry of Climate Change in coordination with provincial authorities, the World Bank, and the Food and Agriculture Organization, aiming to reduce deforestation-driven emissions while strengthening local institutional capacity (Tahir et al., 2024; Olsen et al., 2022). The International Union for Conservation of Nature estimated in 2018 that the programme could reduce carbon dioxide emissions by 35 million tonnes annually (Zeng et al., 2020), and a documented case in Chitral district, funded by the United Nations Development Programme, produced measurable gains in plantation cover and reduced deforestation (Ali et al., 2020).

Set against this, REDD+ draws the sharpest political ecology critique of the four mechanisms studied. Because it centres on carbon sequestration, it can privilege landowners and businesses that gain control over specific forest areas at the expense of communities who depend on those same forests for their livelihood (Cook et al., 2023; Streck, 2020). Its top-down implementation structure, driven by the World Bank and the Ministry of Climate Change with limited public consultation, compounds this risk (Hussain & Fatima, 2015), while its narrow focus on carbon sequestration can crowd out attention to other conservation priorities such as biodiversity and water management (A. Ali et al., 2020). Inadequate transparency in how these initiatives are managed has, in some documented cases, enabled elite land capture, precisely the outcome the political ecology critique of carbon markets predicts (Saeed, 2020).

5.4 Payments for Ecosystem Services

PES mechanisms channel financial support from industrialised economies to developing-country communities and landowners in exchange for ecosystem preservation, structured as voluntary agreements in which payment is conditional on service provision (Ali & Kamraju, 2023; Gaglio et al., 2023). Pakistan's Billion Tree Tsunami Afforestation Project operates on this model (Haris, 2023), and PES schemes have supported wetland preservation through NGO partnerships, such as the Sindh Community Foundation's work incentivising local farmers, and species-specific conservation, including measures to reduce Markhor hunting (Khan et al., 2021; Khan & Baig, 2020).

Compared with REDD+, PES has the structural advantage of channelling funding more directly to communities, bypassing some layers of government bureaucracy (Kaiser et al., 2023). That advantage does not eliminate the governance problems documented elsewhere in this study, however. Insufficient stakeholder participation in project design has left the needs of marginalised communities inadequately addressed in several documented cases, and corruption or inefficiency in project management has, in others, wasted resources that were meant to reach the communities providing the ecosystem service (Hussain et al., 2023; Martinez et al., 2020). Wunder et al. (2020) situate this pattern within the same political ecology critique that applies to REDD+: PES, by drawing public resources into a private-payment structure, can exacerbate rather than resolve the inequalities it is meant to address.

6. Discussion

6.1 A Common Pattern Across Four Different Instruments

Read side by side, the four mechanisms examined here look less like four independent policy tools and more like four variations on a single underlying arrangement. Each channels external or state capital toward an environmentally beneficial activity; each depends on some intermediary, a bank, a ministry, an NGO, a landowner, to translate that capital into action on the ground; and in each case, the intermediary's interests do not automatically align with the interests of the community the mechanism is meant to serve. Green bonds concentrate in developed economies and do little to build the local human capital needed to sustain a domestic green-finance sector. Debt-for-nature swaps stall on provincial ownership disputes rather than any shortfall in creditor willingness. REDD+ delivers real, documented local gains in specific cases, Chitral among them, while drawing the sharpest critique of any mechanism studied for privileging landowners and corporate carbon interests over the communities that depend on the same forests. PES comes closest to routing funding directly to communities, yet remains vulnerable to the same weak stakeholder participation and governance gaps documented elsewhere.

This pattern is not simply bad luck repeated four times. It is what political ecology predicts when market instruments are layered onto existing power structures without addressing those structures directly. Bakker's (2015) argument that carbon markets exemplify market environmentalism, reproducing rather than correcting the imbalance between global North and South, applies as much to a green bond issued in Islamabad as to a REDD+ project in a forest district: the instrument's technical design is not the variable determining whether it narrows or widens inequality. Who controls implementation is.

6.2 Why REDD+ and PES diverge despite a shared logic

REDD+ and PES share a basic structure, both pay for an environmental outcome, yet the evidence in this study places them at different points on the same spectrum. The difference traces back to design rather than intent. REDD+ in Pakistan is implemented top-down, through the Ministry of Climate Change and the World Bank, with the community's role largely confined to hosting the project rather than shaping it (Hussain & Fatima, 2015). PES schemes, by contrast, more often route funding through NGO

intermediaries working directly with the communities providing the ecosystem service, the Sindh Community Foundation's wetland work being one documented example. That structural difference, not the underlying payment logic, is what produces REDD+'s land-capture risk and PES's comparatively better, if still imperfect, record of reaching the communities it targets. Luintel et al.'s (2018) Nepal case makes the same point from the opposite direction: a carbon-offset project succeeded specifically because the local community held an active role in decision-making, the same variable this study finds missing from Pakistan's REDD+ implementation.

6.3 Theoretical contribution: financial architecture as a political choice

The political ecology literature on carbon markets has tended to critique MBMs as a category, treating cap-and-trade, offsetting and ecosystem payments as variations on a single neoliberal logic (Bakker, 2015; Lohmann, 2006, as discussed in the literature reviewed for this study). This study's contribution is to show, empirically, that the category obscures more than it reveals. Green bonds and debt-for-nature swaps are financing instruments, mechanisms for moving capital; REDD+ and PES are payment-for-outcome instruments, mechanisms for compensating specific behaviour. The equity problems documented here do not track this financing/payment distinction. They track something else: the degree to which the community affected by an instrument also controls how it is implemented. This reframes the standard political ecology critique of market environmentalism in a way that has direct implications for reform. If the financing/payment distinction were the operative variable, reform would mean choosing different instruments. Because control over implementation is the operative variable instead, reform means changing who governs the instruments already in use, a proposition developed further in the policy implications below.

7. Policy Implications

The evidence assembled here points toward a single priority that cuts across all four mechanisms: building a legal and institutional framework that governs how climate finance is allocated, monitored and made accountable to the communities it is meant to benefit, rather than developing additional instruments or expanding the scale of those already in use. Concretely, this means three things. First, REDD+ and PES governance structures should build binding community participation requirements into project design from the outset, following the Nepalese and Sindh Community Foundation examples discussed above, rather than treating consultation as an add-on to a decision already made elsewhere. Second, the persistent inter-ministerial disagreement between the Ministry of Climate Change and the Ministry of Finance over debt-for-nature swaps needs a resolution mechanism with actual authority, since the current pattern of unresolved disagreement functions as a de facto veto on an instrument that could otherwise generate real environmental benefit. Third, green-bond policy should shift resources toward building domestic green human capital, technical and financial literacy inside the institutions expected to originate and manage these instruments, rather than assuming that regulatory frameworks alone will produce a functioning green-finance sector.

None of these recommendations require abandoning market-based mechanisms in favour of the more sweeping structural transformation some political ecologists argue is necessary (Fletcher, 2010, as discussed in the literature reviewed for this study). They are more modest, and for that reason more immediately actionable: they ask Pakistan's climate finance architecture to close the gap between an instrument's stated beneficiary and its actual one, mechanism by mechanism, rather than waiting for a wholesale reordering of the economic system these instruments operate within.

8. Conclusion

This study examined four market-based mechanisms operating in Pakistan, green bonds, debt-for-nature swaps, REDD+ and payments for ecosystem services, through a political ecology lens, asking not only whether each reduces emissions but who controls the process and who benefits from it. Each mechanism proved technically capable of contributing to climate mitigation. Each was also constrained by a governance gap between the entity capturing the mechanism's benefits and the community bearing its costs, a gap political ecology theory predicts and this study's evidence confirms in specific, documented form for each instrument.

The comparison across mechanisms is the study's main contribution. REDD+ and PES share a payment-for-outcome logic yet diverge sharply in practice, a divergence traceable to how much control local communities hold over implementation rather than to the underlying financing model. That finding reframes what reform requires: not a different set of instruments, but different governance built into the instruments already in place.

This study relied entirely on secondary, document-based data, which means it cannot speak to community perceptions of these mechanisms in the communities' own terms, only to what published research and policy documentation report about them. Future research combining this study's document-based approach with primary fieldwork, interviews with affected communities specifically, would test directly whether the participation gap identified here from the documentary record holds up against communities' lived experience of these mechanisms. Comparative work examining whether the same participation variable explains MBM outcomes in other developing economies exposed to similar climate risk would also help establish how far these findings travel beyond the Pakistani case.

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