INSTITUTE FOR GLOBAL PROSPERITY

Prosperity, Innovation and Entrepreneurship MSc
Final Dissertation

Exploring the Impact of Regenerative Finance on Colombia's Prosperity

STUDENT NAME: NICOLAS PRIETO GAMBOA

CANDIDATE NUMBER: DSHN8

MODULE CODE: BGLP0014

WORD COUNT: 16,118

IGP MSc COURSEWORK

DECLARATION OF OWNERSHIP AND COPYRIGHT FORM

1. DECLARATION OF OWNERSHIP

I confirm that I have read and understood the guidelines on plagiarism produced by IGP and UCL, that I understand the meaning of plagiarism as defined in those guidelines, and that I may be penalised for submitting work that has been plagiarised. This piece of coursework must be submitted electronically through Turnitin on Moodle by the stipulated deadline. I understand that the coursework cannot be assessed unless it is submitted online and that penalties will be applied for late submissions as per UCL and IGP guidelines unless there is an approved case for Extenuating Circumstances or Reasonable Adjustments.

I declare that all material is entirely my own work except where explicitly, clearly and individually indicated and that all sources used in its preparation and all quotations are clearly cited using a recognised system for referencing and citation. Should this statement prove to be untrue, I recognise the right of the Board of Examiners to recommend disciplinary action in line with UCL regulations.

2. COPYRIGHT

The copyright of the coursework remains with me as its author. However, I understand that anonymised copies may be made available to future students for reference. Please, tick the box if you DO NOT want this report to be made available for teaching purposes.

☐

Abstract

ReFi has emerged as an ecological movement and alternative financial system to accelerate the transition from an extractive to a regenerative economy. By integrating advanced technologies like blockchain with regenerative principles, ReFi seeks to create transparent and inclusive NbS, from agroforestry to wildlife restoration. A core principle of ReFi is to promote holistic approaches that address multiple impact dimensions beyond carbon offsetting, including biodiversity protection and community development. To achieve this, ReFi practitioners emphasise decentralised, bottom-up approaches that ensure equitable economic and social benefits for all stakeholders involved in climate resilience efforts.

Despite these ambitious objectives and emerging global attention on ReFi, a significant research gap remains regarding its effectiveness, particularly in biodiversity-rich countries with large rural and Indigenous populations, such as Colombia. This study addresses this gap by comparing ReFi's theoretical propositions, established through a literature review, with empirical evidence from a comparative case study of six ReFi initiatives operating in Colombia. The data obtained from semi-structured interviews with founders and practitioners provides valuable insights into the movement's current state, significant challenges, and opportunities to progress. The research reveals that while ReFi has transformative potential for creating participatory solutions for planetary regeneration, it remains in its infancy and faces structural implementation and scalability barriers. These challenges are primarily linked to negative perceptions of cryptocurrency and Web3, the dominance of traditional carbon market entities, and difficulties in translating regenerative principles and technologies into actionable, grassroots solutions that communities can widely adopt.

Table of Contents

List of Abbreviations

Abbreviation	Meaning
ACR	American Carbon Registry
AI	Artificial Intelligence
BCT	Base Carbon Ton
BICOWG	Blockchain Infrastructure Carbon Offset Working Group
BRF	Barichara Regeneration Fund
CAR	Climate Action Reserve
CBI	Climate Bonds Initiative
CFA	Climate Finance Accelerator
CGIAR	Consultative Group for International Agricultural Research (
CKH	Carbon Knowledge Hub
CLIP	Centre for Investigative Journalism
CO2	Carbon Dioxide
CO2e	Carbon Dioxide Equivalent
CPI	Climate Policy Initiative
CPR	Common Pool Resources
D-MRV	Digital Measurement, Reporting, and Verification
DAO	Decentralised Autonomous Organisation
DeFi	Decentralised Finance
EDF	Environmental Defense Fund
ELN	Ejercito de Liberacion Nacional
ES	Ecosystem Services
ESG	Environmental, Social, and Governance
EU ETS	European Union Emissions Trading System
FARC	Fuerzas Armadas Revolucionarias de Colombia
GBP	Green Bond Principles
GDP	Gross Domestic Product
GFP	Green Finance Project
GHG	Greenhouse Gases
ICI	International Climate Initiative
ICMA	International Capital Market Association
IDP	Internally Displaced People
IoT	Internet of Things
MCO2	Moss Carbon Credit
MRV	Measurement, Reporting, and Verification
NbS	Nature-base Solutions
NDC	Nationally Determined Contribution
NFTs	Non-fungible Tokens
PCF	Prototype Carbon Fund
PES	Payment for Ecosystem Services

PoS	Proof of Stake
PoW	Proof of Work
RECs	Renewable energy credits
REDD+	Reducing Emissions from Deforestation and Forest Degradation
ReFi	Regenerative Finance
SDGs	United Nations Sustainable Development Goals
TCC	Truth Commission of Colombia
UN WCED	United Nations World Commission on Environment and Development
UNEP	United Nations Environmental Programme
WID	World Inequality Database
WRM	World Rainforest Movement
WWF	World Wildlife Fund

List of Illustrations

Acknowledgements

My sincere gratitude to my supervisor, Dr Christopher Harker, whose profound expertise in financial systems and guidance have been invaluable throughout this research. His insightful advice and continuous support played a crucial role in developing this dissertation.

I am also profoundly thankful to the interviewees for generously sharing their insights and experiences, which were critical to the depth and richness of this study.

Finally, I extend my heartfelt thanks to my mother, Luisa, whose exemplary resilience and courage have inspired me to dream big, persevere through challenges, and remain steadfast in my journey.

1. Introduction

1.1 Background

The alarming consequences of climate change have prompted societies worldwide to explore innovative economic models, redirecting resources towards investments in NbS, such as reforestation and renewable energies projects, to mitigate greenhouse gas emissions and foster resilient ecosystems (UNEP, 2020). Carbon credit markets have emerged as the leading instrument for financing NbS. In this system, NbS project developers issue credits based on how much carbon they help remove or prevent from entering the atmosphere. These carbon credits can be sold to companies or public entities to help them meet their carbon reduction targets. This creates an incentive system that redirects financial resources towards achieving climate goals.

However, the absence of robust project verification and a unified credit origination and traceability system has undermined the effectiveness of the carbon markets, leading to the proliferation of fraudulent practices such as credit double-counting and greenwashing (Marchant, Cooper and Gough-Stone, 2022). Additionally, the market's structure, relying on various intermediaries such as credit registry companies, third-party verifiers, and brokers, results in high costs and complexity for developing and issuing carbon credits. Consequently, this exclusionary dynamic has prevented small landowners and rural communities from participating in and benefiting from carbon markets (Bumpus, 2011). Additionally, it has perpetuated unequal development patterns and restricted opportunities for local communities to contribute to the governance and design of emerging green finance instruments (Bozmoski, Lemos and Boyd, 2008).

Moreover, the carbon market has conducted global efforts to achieve carbon neutrality as the ultimate solution for climate change. However, this emphasis has overshadowed more systemic and long-term solutions, such as redefining economic value and wealth in harmony with the planet's health or altering destructive societal consumption behaviours (Bachram, 2004). This approach has also faced criticism for enabling organisations to continue extractive practices by simply purchasing carbon credits instead of actively transforming their operating models. Furthermore, various carbon project developers have been found to lack ethical standards, prioritising profitability over sustainability (Lohmann, 2005). This is exemplified by practices such as degrading biodiversity-rich ecosystems through the establishment of monoculture carbon-offsetting plantations and displacing local communities to make way for new carbon projects.

Furthermore, the current voluntary carbon market arrangement, primarily dominated by corporations and financial intermediaries from the Global North, frequently dictates and alters land management and economic systems in the Global South, where most

NbS are implemented. The absence of social equity criteria and accountability in these carbon projects exacerbates this issue, perpetuating historical colonialist dynamics (Evite and Zara, 2023). According to the Carbon Brief (2023), there have been over 61 documented instances of manipulation and exploitation in carbon projects, which include harm to Indigenous communities, disruptions to food and natural production, overestimation of offsets, and illegal land use. These incidents have predominantly been reported in Latin America (Dunne and Quiroz, 2023).

Since 2017, ReFi has emerged as an alternative environmental movement in response to these challenges (Schletz et al., 2023). ReFi advocates aim to create economic systems, practices, and strategies that fund regenerative and restorative outcomes while incorporating ethical and inclusive practices (Carbon Copy, 2024). By harnessing blockchain-based mechanisms such as D-MRV, nature tokenisation, and DAOs, ReFi aims to create more efficient and equitable financial and regenerative models by removing intermediaries, lowering entry costs, ensuring fair resource distribution, and balancing decision-making among stakeholders (Hartley and Rennie, 2022). For such aspirations, the nature of blockchain technology may enhance transparency by making all participants and climate-related transaction records publicly available, avoiding fraudulent practices such as credit double-counting. Consequently, this approach strives to strengthen the integrity of green finance instruments and significantly increase the accessibility and participation of vulnerable communities in the Global South.

One of the most promising countries for ReFi to flourish is Colombia, renowned as the most biodiverse country per square kilometre globally (BIOFIN, 2023) and home to over 170 indigenous and ethnic communities, who manage approximately 25% of the nation's land and water resources (Jordan, 2023). This unique biodiversity and community stewardship have captured the attention of climate scientists and entrepreneurs worldwide who aim to protect crucial ecosystems while fostering sustainable models for local communities. However, significant challenges in implementation persist, such as aligning global conservation objectives with the communities' cosmovision of land management and establishing profitable models that incentivise locals to participate in environmental efforts. Although Indigenous and rural communities share a deep understanding of the importance of nature, the country's violent internal conflicts and lack of economic opportunities have generated widespread poverty and inequality among them (Lemus, 2014). Therefore, many are forced to exploit their lands through environmentally damaging activities such as cattle ranching or illegal mining to survive.

1.2 Aims and Objectives

ReFi has garnered significant attention in digital media and entrepreneurial circles for its innovative approach to climate change mitigation, frequently associated with terminology such as ‘holistic thinking,’ ‘blockchain for good,’ and ‘regenerative

economy.' However, given the ongoing issues and fraudulent practices in carbon markets, it is essential to investigate whether these concepts genuinely lead to transformative, actionable solutions or simply perpetuate the dominant climate narrative without driving meaningful progress.

The primary goal of examining ReFi in Colombia is to assess its real-world effectiveness beyond the appealing rhetoric often associated with it. This research aims to identify key implementation challenges and evaluate whether ReFi genuinely promotes participatory, climate-positive models. To achieve this, it will compare practical use cases to determine if they effectively reduce economic and social disparities, particularly among the most disadvantaged communities in developing countries. The study will focus on ReFi's advancements in Colombia, considering its environmental, social, and entrepreneurial dimensions.

1.3 Research Questions

By comparing the theoretical principles and rhetoric of ReFi discussed in the literature review with the practical challenges identified in the comparative case study, this study aims to address the following research questions:

1. How is the ReFi movement advancing in Colombia, and what impact is it generating on local communities?

1.1 What are the main challenges ReFi initiatives face regarding implementation and scalability?

1.2 How do ReFi initiatives engage and measure their impact on local communities?

Ultimately, the goal of this study is to offer valuable insights for future policymakers and entrepreneurs to guide the development of effective regenerative models both locally and globally by analysing the ReFi movement's progress, challenges, and community impact in Colombia.

1.4 Structure

The research will begin with a comprehensive literature review in Chapter 2, examining the functioning of the current green finance system and highlighting critical issues in developing climate change solutions. This includes addressing concerns such as fraud and manipulation in carbon credit markets and the persistence of colonialist practices that exacerbate social inequities between the Global North and South. The literature review will then introduce new paradigms of sustainability and prosperity, the principles of regenerative movements and the emergence of ReFi. Finally, the literature review will contextualise Colombia's unique natural characteristics, the

complex interplay between conflict, peacemaking, and conservation, and the country's green taxonomy and environmental policies. This review will lay the groundwork for analysing the narratives and data collected from the interviewees.

Subsequently, Chapter 3 will outline the comparative case study methodology, which includes semi-structured interviews with the founders of six ReFi organisations in Colombia and two external experts in biodiversity and green finance. Chapter 4 will present the findings from these interviews, organised through a thematic analysis. Building on these findings, Chapter 5 will offer an in-depth discussion, critically comparing the theoretical framework established in the literature review with the study's data to address the research questions. Finally, Chapter 6 will conclude the research and outline its limitations and recommendations for future studies.

2. Literature Review

2.1 Green Finance

To achieve the temperature and adaptation goals outlined in the Paris Agreement (2015), it is imperative to transition towards carbon-neutral economies by 2050. NbS are poised to play a pivotal role in this transition, potentially contributing up to 30% of the mitigation and adaptation necessary to limit global warming to 1.5°C (IUCN, 2022). These solutions encompass three primary strategies: reducing greenhouse gas emissions, capturing and storing atmospheric carbon dioxide, and enhancing ecosystem resilience.

Despite the critical importance of NbS, less than 2% of global financial resources currently support these mechanisms (Landholm et al., 2022). The CPI (2021) also estimates that funding for climate resilience efforts must increase by at least 590% annually to meet the 2030 internationally agreed climate goals and avert severe global warming. This funding gap is due to various factors, including inefficient mechanisms, high upfront costs, uncertain investment returns, regulatory barriers, and a lack of market transparency and stakeholder coordination (Fu, Lu, and Pirabi, 2023; Agrawal et al., 2024). However, The GFP (2022) has reported a 317% increase in regulations, policies, and market-based instruments supporting NbS financing since the Paris Agreement, indicating the global development of 'green finance.'

Green finance encompasses financial instruments and strategies to foster investments in NbS projects, environmental products, services, and policies to develop sustainable economies (Fleming, 2020). This includes mobilising capital for diverse climate-related investments, such as renewable energy technologies, energy-efficient infrastructure, regenerative agriculture, and sustainable transportation (Soundarrajan and Vivek, 2016; Fu, Lu, and Pirabi, 2023). Although green finance lacks an official definition or specific scope (Lindenberg, 2017), it arises from the recognition that traditional financing alone cannot support the transition to a low-carbon or carbon-neutral

economy (Campiglio, 2016). Ultimately, scaling profitable green finance models aims to incentivise public and private entities to prioritise sustainable investments over those that contribute to unsustainable growth (GPF, 2020), such as coal mining or oil drilling. Moreover, green financial instruments and legal frameworks aim to mitigate the high-risk profile of NbS investments by providing guidelines for long-term funding strategies and patient capital. This includes new return and capital performance metrics aligned with ESG criteria (Appendix A) and the UN SDGs (Appendix B) (Bhatnagar et al., 2022).

Although still insufficient, green finance has experienced significant global growth in recent years, exemplified by the issuance of green loans and bonds surpassing 1 trillion USD (CBI, 2024). Additionally, there has been a notable rise in green investment funds and the integration of environmental criteria into public investment decisions, driven by collaborations among central banks, governments, and multilateral institutions (Dikau and Volz, 2021). For instance, UNEP (2018) has outlined three key strategies to promote global green finance efforts. First, it supports the public sector by reviewing policy and regulatory frameworks for financing systems and developing green taxonomies. Second, it fosters multi-stakeholder partnerships by engaging critical financial market actors, including banks, investors, micro-credit entities, insurance companies, and the public sector. Finally, it empowers community enterprises to develop Nature-based Solutions (NbS) through micro-credit initiatives.

2.1.1 Nature Commodification

A fundamental mechanism in the global adoption of green finance has been the ‘commodification’ of nature through carbon and biodiversity accounting systems (Martineau and Lafontaine, 2019). This process involves three main phases, as Keucheyan (2014) outlined. First, nature is conceived as ‘capitalised property,’ capable of generating future income streams, providing services and incurring liabilities and obligations (Birch, 2017). Second, nature is abstracted or ‘disembedded’ from its holistic context. Finally, it is transformed into a fictitious, commensurable commodity with an assigned exchange value, such as tons of CO2, for commercialisation. According to various scholars, this process dissociates nature from its essence by promoting a purely utilitarian view that lacks emotional and affective dimensions (Paterson and Stripple, 2012; Lohmann, 2010; Descheneau, 2012).

However, the commodification of nature is more similar to the provision of services than the trade of conventional commodities like gold or coal, which can be easily extracted, bought, and sold (Bridge et al., 2019). For instance, in the case of carbon, the ‘service’ refers to nature’s evaluated and verified capacity to reduce atmospheric carbon emissions or maintain ecosystem resilience. This perspective of nature as a service has given rise to alternative models, such as PES.

ES were first defined by Costanza and colleagues in 1997 as ‘the benefits that human populations gain, directly or indirectly, from ecosystem functions’ (Costanza et al., 1997: 253), estimating their global value at 33 trillion USD. Building on this concept, PES operates as a voluntary transaction, where an ES buyer purchases a well-defined service from an ES provider, contingent on the assurance of its provision (Wunder, 2005). Since its inception, PES has been extensively analysed, offering a promising market-based mechanism to preserve biodiversity and promote sustainable development by internalising the previously overlooked value of natural services (Costanza et al., 1997).

An exemplary case of PES emerged in 1996 when the Costa Rican government established a program to incentivise reforestation through a combination of rules, regulations, and financial rewards. Private landowners received compensation from a government-managed fund supported by private and international donors in exchange for providing ecosystem services such as forest protection, agroforestry, and sustainable forest management (Porras and Chacon-Cascante, 2018). This strategy addressed market failures caused by resource extraction, helping to generate private benefits and encourage sustainable practices that preserve ecosystem resilience (Van Hecken and Bastiaensen, 2010).

Nevertheless, PES and other forms of nature commodification have been heavily criticised as forms of ‘fetishisation.’ Marx's concept of ‘commodity fetishism’ (1867) depicts how capitalist systems obscure the social and environmental relationships behind production, focusing solely on economic measures like pricing. In the context of nature, this narrow view can mask nature's broader social and cultural significance, preventing societies from recognising the exploitative relationships that can emerge in market-based green instruments. Allowing nature to be traded creates power imbalances in production, distribution, and consumption, leading to pricing, payment conditions, and market access inequalities. Thus, profits from these transactions often flow to dominant groups, such as large corporations and carbon registries, rather than the communities directly connected to these ecosystems (Kosoy and Corbera, 2010; Pérez-Català, 2014). This dynamic results in unequal and exclusionary outcomes (Muradian et al., 2013) and perpetuates the controversial notion of ‘selling nature to save it’ (Pérez-Català, 2014).

2.1.2 Instruments

The commodification of nature has led to the development of various green finance instruments, with green bonds and carbon credits being the most widely adopted. These instruments have been pivotal in mobilising capital for Nature-based Solutions (NbS) and other sustainable projects. Green bonds are used to fund environmentally beneficial initiatives, while carbon credits enable entities to offset their emissions by investing in reduction efforts. This proliferation has also spurred the creation of new

institutions, including green banks, exchange platforms, and specialised funds (GFP, 2020).

2.1.2.1 Green Bonds

Green bonds are debt instruments used to raise capital for projects with environmental benefits (Bhutta et al., 2022). They operate like traditional bonds, providing regular interest payments and returning the principal at maturity, promising that the funds will be used for green projects such as renewable energy, energy efficiency, and sustainable infrastructure. While organisations like ICMA have set criteria for green bonds, granting a green label if projects meet the GBPs, a key concern for investors remains regarding the verification of promised environmental benefits (Beschloss and Mashayekhi, 2019). Although larger, experienced investors can assess these benefits through impact reports and due diligence, smaller investors may lack the resources for such evaluations.

2.1.2.2 Carbon Markets

Alternatively, carbon credits are tradable units of GHG, usually measured in tons of CO2e, that have been either reduced or removed from the atmosphere (Best, Burke, and Jotzo, 2020). These credits are traded in both voluntary and regulatory carbon markets. Carbon markets involve pricing and trading two types of carbon credits: allowances, which grant regulated organisations the right to emit carbon dioxide, and offsets, which are transferable credits generated from activities that reduce emissions (Bridge et al., 2019).

2.1.2.2.1 Regulatory Carbon Markets

In a cap-and-trade system, such as the EU ETS, the largest of its kind, a regulatory authority sets a maximum limit, or cap, on total allowable GHG emissions for a specified group of entities, including nations, industries, or companies (Convery, Perthuis, and Ellerman, 2008). Emission permits are auctioned or allocated based on reduction targets, and the cap is divided into individual allowances or credits, which are distributed to the regulated entities. Entities that emit less than their cap can sell surplus allowances to those exceeding their limits or save them for future use (EDF, 2020). This system incentivises emission reductions by trading and banking credits (Buckley, Mestelman, and Muller, 2005). Additionally, regulatory authorities typically lower these caps over time, encouraging industries to improve their emission reduction efforts while continuously managing costs effectively.

In contrast, a baseline-and-credit scheme assigns each entity a baseline permittable emissions level based on past data or performance standards relative to output instead of absolute caps. Firms earn credits by emitting less carbon than their

baseline, which can be saved or sold to others exceeding their limits. Unlike cap-and-trade systems, these credits are often calculated on a project-by-project basis and must be certified and registered before trading (Enabulele, Zahraa, and Ngwu, 2016), usually after reductions have been achieved (Betz et al., 2022; Buckley, Mestelman, and Muller, 2005).

Additionally, some countries have opted to introduce a carbon tax that requires companies or individuals to pay a fixed amount per unit of GHG emissions. This tax may apply at various stages, such as the supply, retail, importation, or use of fossil fuels, with rates varying by fuel type or sector. In some jurisdictions, including South Africa and Colombia, carbon offsets from projects that reduce, remove, or avoid emissions are allowed as an alternative to paying the carbon tax (Advani et al., 2021).

The decision to implement a carbon tax, cap-and-trade system, or baseline-and-credit scheme involves trade-offs between price certainty and emission reduction guarantees (CKH, 2022). A carbon tax offers cost certainty by setting a fixed price per unit of emissions, but it doesn't guarantee specific reductions. Setting the tax rate is also politically challenging, as a low rate may fail to drive reductions, while a high rate could impose significant costs and stifle economic growth (Goulder and Schein, 2013; Revelle, 2009). In contrast, cap-and-trade systems ensure measurable emission reductions through an absolute cap and promote investment but are more complex and costly to implement (Allayannis and Tenguria, 2009). Baseline-and-credit schemes set emissions targets based on production intensity rather than absolute limits, protecting companies facing international competition and avoiding cost pass-through to consumers. However, these schemes introduce uncertainty due to fluctuating production levels and emission intensities, complicating predictions of total reductions. Additionally, they are vulnerable to manipulation of baselines (Buckley, Mestelman, and Muller, 2005).

Aspect	Taxes	Markets: Cap-and-trade Schemes	Markets: Baseline-and-credit Schemes
Certainty	↑ Fixed price ↓ No emissions-reduction certainty ↓ Setting the tax rate is difficult	↑ Emissions-reduction certainty ↓ Price not fixed	↓ No emissions-reduction certainty ↓ More uncertainty on participants' obligations
Complexity	↑ Meant to be simpler for policymakers and companies	↓ Complex and costly for policymakers and companies	↓ More complex and costly for policymakers and companies
Acceptability	↓ Historically less politically acceptable	↑ Historically more popular	↓ Historically less popular

Figure 1: Adapted from Carbon Taxes Versus Markets (CKH, 2022).

2.1.2.2.2 Voluntary Carbon Markets

Unlike regulatory markets, voluntary carbon markets are driven by organisations, industry associations, and individuals who choose to offset their emissions beyond legal requirements. Participants in these markets purchase carbon credits to meet self-imposed sustainability goals motivated by corporate social responsibility, consumer demand, or brand enhancement (Favasuli and Sebastian, 2021). There are two main types of carbon credits: avoidance credits, which prevent emissions by protecting ecosystems like forests and peatlands, as seen in REDD+ projects, and removal credits, which actively remove CO2 from the atmosphere through methods like reforestation or technological solutions such as carbon capture and storage (Plasencia, 2024). Avoidance credits are more controversial and uncertain because they focus on preventing future emissions rather than reducing current levels. In contrast, removal credits are generally considered more valuable because they directly reduce current atmospheric CO2, providing a more immediate and measurable impact on climate mitigation.

Over the past two decades, voluntary carbon markets have significantly advanced environmental initiatives within the private sector (Spilker and Nugent, 2022). These markets involve various stakeholders and intermediaries, including project developers, carbon buyers, standard organisations, verification bodies, financial institutions, and brokers operating in spot or cash markets (Bose et al., 2021). Standard and verification entities often compete to develop advanced methodologies and rules for calculating benefits and generating carbon credits for both avoidance and removal projects. Verra, CAR, ACR, and Gold Standard are among the most established entities known for their sophisticated methodologies. In contrast, smaller niche standards are gradually emerging, often providing lower-quality credits (Ahonen et al., 2022).

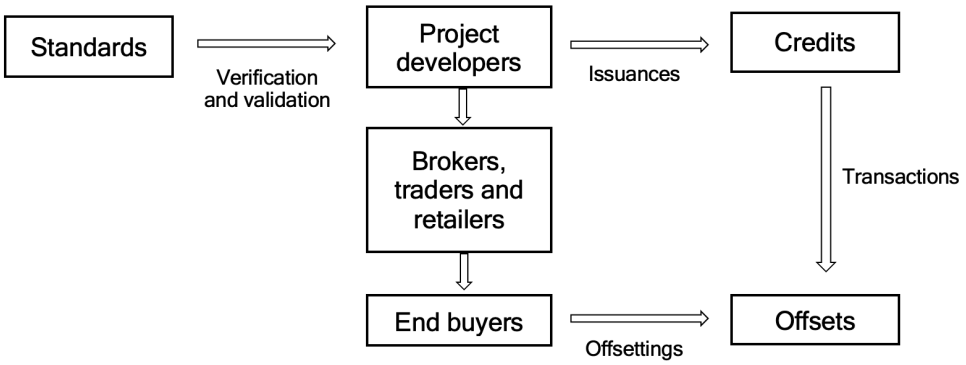

Figure 2: Adapted from The Structure of The Voluntary Carbon Market (Favasuli and Sebastian, 2021).

Nevertheless, using carbon credits as a corporate climate strategy has become controversial, with some companies using offsetting to avoid meaningful long-term climate action (Kreibich and Hermwille, 2021). Moreover, the fragmented landscape of voluntary carbon standards has led to discrepancies, as each registry sets its own

methodology, raising risks for environmental and data integrity, with double-counting being a predominant issue (Ahonen et al., 2022). Double-counting occurs when multiple national or international entities claim the same carbon offset. This usually happens due to obscure reporting and verification processes, a lack of inter-registries governance or centralised carbon tracking systems (Schneider and La Hoz, 2018). Consequently, carbon reduction efforts become inaccurate, overestimating total emission reductions and undermining market integrity. This duplication also creates a false sense of progress, reducing the incentive for further emissions reduction efforts (Kreibich and Hermwille, 2021). While significant funds are directed towards establishing voluntary carbon trading schemes, minimal resources are allocated to their regulation or unification (Bachram, 2004). This imbalance has left the market alarmingly dependent on the integrity of these institutions to report emissions and reductions accurately, which has led to severe credibility issues.

For instance, a recent investigation by the Guardian and Die Zeit in collaboration with SourceMaterial NGO (Greenfield, 2023) revealed that the forest avoidance projects certified by Verra, the largest carbon standard used by major corporations like Disney, Shell, and Gucci, are mostly ineffective and lack any positive ecological impact. The research also indicates that over 90% of Verra's rainforest offset credits, commonly used by companies claiming to be 'carbon neutral,' are likely 'phantom credits' that are not genuinely protecting the delimited forest areas.

2.2 Carbon Colonialism

It is widely acknowledged that those most responsible for the life-threatening impacts of climate change are often the least exposed to its severe effects and have the most resources to protect themselves (Paul, 2021; Bhambra and Newell, 2023). The WID reported that the wealthiest 10% of the global population is responsible for nearly 48% of worldwide emissions, with the top 1% alone accounting for 17% of the total (Chancel, 2021).

Furthermore, proposed climate change solutions often reinforce, rather than address, social and ecological inequalities. For instance, various Global North countries reduce carbon emissions by outsourcing carbon-intensive processes, such as manufacturing, to the Global South (Newell, 2021). Additionally, the neoliberal logic of carbon markets allows organisations in the Global North to offset their emissions by establishing carbon projects in underprivileged communities in the Global South, where labour costs are lower and natural resources are abundant, instead of decreasing reductions internally (Bumpus and Liverman, 2008; Bachram, 2004; Dentzel, 2023).

Moreover, while carbon offset projects are often promoted as 'triple win' initiatives benefiting investors, the environment, and local communities (Larsson and Orvehed, 2021; Richards and Lyons, 2016), this portrayal remains more discourse than reality. In practice, many NbS projects in the Global South replicate historical patterns of

exploitation, such as detrimental labour conditions and ‘green grabbing,’ a term defined by Fairhead, Leach, and Scoones (2012) as ‘the appropriation of land and resources for environmental purposes.’ This process often fosters inequitable development, exacerbates poverty, and can be seen as a form of neocolonialism (Dehm, 2016).

Green grabbing has primarily occurred through the establishment of large-scale monoculture plantations, which are single-species tree farms mainly created for carbon sequestration. These plantations frequently result in power imbalances, such as land use and ownership shifts, and local livelihood disruptions, transferring control from local communities to corporations or foreign investors (Kröger, 2014; Liu, Kuchma, & Krutovsky, 2018).

In Latin America, for instance, the Plantar organisation, backed by major international investors such as the World Bank PCF and the Canadian government, established a 12,300-hectare eucalyptus plantation to generate around US$25 million in carbon credits. Although tree planting can restore degraded landscapes and provide timber, fast-growing species that require large amounts of water may threaten biodiversity and cause socio-environmental harm. Therefore, introducing this water-intensive species into Brazil’s Cerrado savannah depleted vital water sources and negatively impacted local biodiversity by eliminating native animals and vegetation (Lohmann, 2005; WRM, 2003).

In addition to the ecological disruption, the social impact on local communities was devastating. The company illegally dispossessed Indigenous people of their lands, caused water scarcity for agriculture, destroyed jobs and livelihoods, and further threatened the health of the community (Bachram, 2004). Additionally, many locals working on the plantations reported exploitative labour conditions. Despite protests from over 70 Brazilian communities, churches, and labour organisations, calls to halt investments in the Plantar project have been mainly disregarded (WRM, 2003). Beyond the Plantar case, more than 60 additional incidents of environmental exploitation and alteration were documented by The Carbon Brief by 2023, highlighting how current carbon market systems may disproportionately impact the poorest, most vulnerable, and excluded communities, especially in rural areas (Dunne and Quiroz, 2023).

A less explicit form of colonialism in current carbon markets is the dominance of the ‘Western discourse,’ which often prioritises technological, economic, and scientific discussions, excluding other forms of knowledge (Mignolo, 2019). Moreover, this perspective overlooks local and Indigenous value systems, such as Sumak Kawsay, Suma Qamaña, and Buen Vivir in Latin America, which emphasise more sustainable ways of 'living in harmony and plenitude’ (Artaraz et al., 2021). Thus, these Indigenous frameworks may offer more effective approaches to understanding the holistic

relationship between humans and the Earth and implementing NbS (Larsson and Orvehed, 2021).

To address climate change effectively, it is essential to recognise the distinct realities faced by the Global South and the Global North, which involve different capacities, resources, perceptions, and political priorities (Strazzante, Rycken, and Winkler, 2021). This requires decolonising climate practices, starting with decolonising the mind and envisioning a future free from imposed ideals. Consequently, humanity must move beyond the Western rhetoric of 'development,' including the prevailing concept of 'sustainable development,' and embrace diverse and sustainable economies that position the economy as a component of society rather than placing society in subordination to the economy (Mignolo, 2019).

2.3 From Sustainable to Regenerative

The original aim of sustainable development, as articulated in the WCED report: ‘Our Common Future,’ is to fulfil the requirements of current generations without jeopardising the ability of future ones to satisfy their own needs (Brundtland, 1987). However, a growing school of thought argues that the widespread adoption of linear and destructive economic practices has already undermined planetary boundaries, demonstrating that merely maintaining the current state of the environment is insufficient to ensure a secure future for subsequent generations (Müller, 2020).

This ideological shift challenges conventional, anthropocentric, and reductionist approaches to sustainability, which traditionally view humans and nature as separate entities and consider environmental resources to exist primarily to serve human consumption (Müller, 2020; Gibbons, 2020). In recent decades, the regenerative movement has sparked significant debate in organisational studies, yet its framework and differentiation from other movements, such as the circular economy, remain subjects of discussion (Konietzko, Das, and Bocken, 2023). Despite this, the movement has gained traction under various terms, including ‘regenerative economics,’ ‘regenerative development,’ and ‘regenerative sustainability’ (Pedley, 2024). At its core, this intellectual current advocates for practices that not only aim for a net-zero environmental impact but strive to create a net-positive effect, embracing regeneration's intrinsic ability to ‘bring into existence again’ (Muñoz and Branzei, 2021; Stokel-Walker, 2022).

Moreover, proponents of regenerative movements argue that current strategies to adress the ‘grand challenges’ threatening Earth's living systems are fragmented and overly narrow in focus (Müller, 2020; Munafò et al., 2017). The central issue stems from the tendency of scientists and scholars worldwide to work in isolation or within their siloed disciplines, lacking sufficient interdisciplinary collaboration and shared understanding.

As a solution, the regenerative movement, generally aligned with decolonisation discourses, advocates for integrating non-physical, cultural, and spiritual dimensions into green finance and NbS (Jain, 2021; Fullerton, 2015). Therefore, regenerative advocates envision a future where both the biosphere and social systems are revitalised, fostering a mutually supportive relationship between individuals and their environments and enhancing one another's potential (Du Plessis & Brandon, 2015). Consequently, scholars like Gibbons (2020) emphasise the need to reconcile the outer and inner dimensions of sustainability to operationalise this vision.

Traditionally, sustainable development has centred on creating policies, governance structures, and financial instruments to halt environmental degradation, addressing only 'the outer.' However, achieving systemic change requires fostering consciousness, spirituality, reflexivity, diversity, and shifts in collective values (Horlings, 2015). Thus, sustainability should evolve beyond top-down bureaucratic strategies to embrace bottom-up initiatives rooted in participatory governance, social services, rituals, ceremonies, education, and consciousness-based practices that honour the sovereignty of Indigenous and local communities (Velasco-Herrejón, Bauwens, and Calisto Friant, 2022).

2.4 Prosperity and Regeneration

Accordingly, transitioning to regenerative futures requires fundamentally rethinking how societies measure wealth and well-being (Fullerton, 2015). Traditionally, neoliberal and Keynesian perspectives have focused on individual or national capital accumulation, most notably through metrics like GDP (Jain, 2021). However, GDP 'fetishises' prosperity by considering only monetary transactions related to goods and services. This offers an incomplete view of the economy by ignoring the social and environmental systems it relies on (Costanza et al., 2009). To truly achieve well-being and shared prosperity, nations must acknowledge the failure of the notion of endless economic growth (Jackson, 2009). Despite the global economy growing fivefold over the past century, humanity has degraded 60% of the world's ecosystems, and one-fifth of the worldwide population earns just 2% of global income, with inequality now at unprecedented levels (Mastini, 2017).

Therefore, new metrics of prosperity should be integrated into national and international policies, prioritising aspects of well-being such as the capacity to give and receive love, earn respect from peers, contribute meaningfully to society, and cultivate a sense of belonging and trust within the community (Jackson, 2009). Nevertheless, scholars such as Moore et al. (2015) argue that while redefining prosperity requires moving beyond income-based metrics, the goal is not to impose new universal standards, potentially preserving the Western discourse. Instead, the goal is to develop context-specific definitions of prosperity that embrace diverse perspectives and practices at a local level.

An alternative way to rethink prosperity is by recognising the diverse types of capital that exist on the planet. Roland and Landua (2013) draw on permaculture's design philosophy and practical approach to sustainable living and land management to propose a framework of eight forms of capital: financial, material, living, social, intellectual, experiential, spiritual, and cultural. These forms represent a broad spectrum of resources that, when considered together, provide a more holistic and sustainable understanding of wealth. This perspective shifts the focus away from purely monetary metrics, acknowledging that long-term prosperity depends on the health of ecological systems, the strength of social relationships, and the richness of cultural and experiential knowledge.

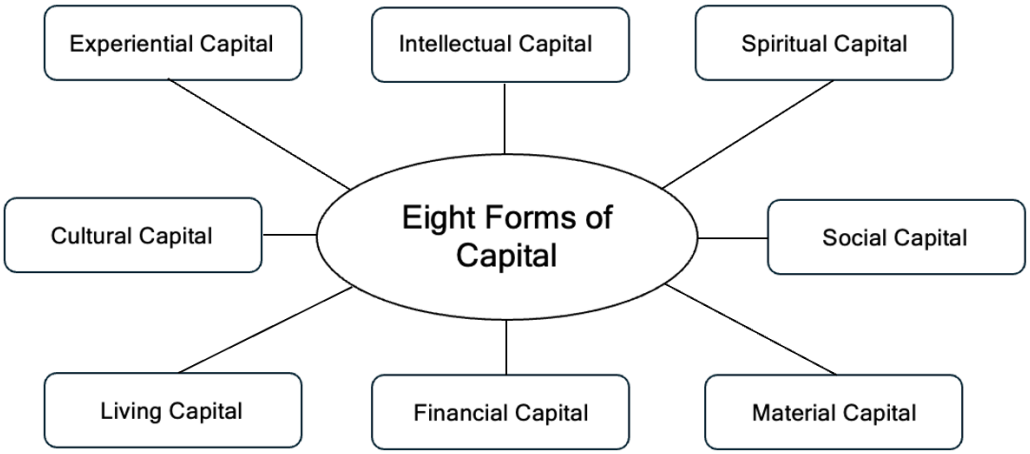

Figure 3: Adapted from Regenerative Enterprise (Roland and Landua, 2013).

Ultimately, while the crisis in the current sustainability and economic development paradigm threatens civilisational collapse and species extinction, it also presents a unique opportunity to develop more effective strategies (González-Márquez and Toledo, 2020). However, this transition is particularly challenging, as it requires humanity to fundamentally rethink and redesign its entire collective model of progress (Buckton et al., 2023). Thus, moving toward regenerative systems will depend on the convergence of multiple academic disciplines, including ecology, quantum physics, systems theory, psychology, neuroscience, design, urban planning, and sustainability (Gibbons, 2020).

2.5 Regenerative Capitalism

In 2010, John Fullerton, an American economist and impact investor, founded the Capital Institute to reimagine economics and finance in service of life systems. Five years later, in 2015, Fullerton introduced the concept of ‘regenerative capitalism,’ widely considered the foundational basis of ReFi. Fullerton’s framework is based on the hypothesis that naturally sustainable and regenerative patterns, such as self-

organisation, self-renewal, and holistic functioning, within which all living systems are interconnected to achieve 'systemic health', can be applied to non-living or socioeconomic systems. Essentially, it involves biomimicking nature's behaviours, such as wholeness, adaptability, and interconnectivity, while applying them to diverse fields, including agriculture, healthcare, finance, and urban planning (Stokel-Walker, 2022).

Although Fullerton (2015) strongly criticises neoliberalism, arguing that it continuously extracts money, talent, and resources from local communities, he clarifies that regenerative capitalism is not a confrontation between capitalism and socialism, as both can be equally unsustainable. Instead, he suggests market-based and business practices may help accelerate the transition to regenerative futures. Fullerton's concept of capitalism encompasses an integrated understanding of multiple forms of capital, as previously proposed by Roland and Landua (2013). To illustrate this vision, he outlined eight principles intended to guide planet-scale regeneration initiatives.

In Right Relationship	• Economic value should be aligned with the health of the whole system through the principles of reciprocity and mutualism.
Views Wealth Holistically	• True wealth includes multiple forms of capital, beyond financial, to encompass ecological systems, relationships, and well-being.
Innovative, Adaptive, Responsive	• Adaptability and innovation are crucial for health and survival, focusing on long-term systemic health rather than short-term gains.
Empowered Participation	• All individuals must contribute to and engage with the system, balancing their needs with the health of the larger whole.
Honours Community and Place	• Resilient communities are rooted in their unique histories and places, while universal principles are adapted to local contexts.
Edge Effect Abundance	• Creativity thrives at the edges of systems, fostering innovation and growth through collaboration and diversity.
Robust Circulatory Flow	• A healthy economy, like a living organism, requires the continuous flow of resources, information, and empathy to maintain its health.
Dynamic Balance	• Regenerative systems seek harmony by balancing various forces (e.g., competition vs. collaboration) to maintain overall system health.

Figure 4: Adapted from Eight Principles of Regenerative Economy (Fullerton, 2015)

2.6 Regenerative Finance

ReFi is a concept that emerged in early 2017 (ReFi DAO, 2023) with the aim of developing real-world applications and financial instruments to direct resources towards regenerative initiatives. Due to its novelty, ReFi lacks a universally accepted definition, precise framework, and standardised applications (Schletz et al., 2023). As a result, its scope and practical application continue to evolve. However, two key elements are commonly shared across various interpretations of ReFi. First, it draws heavily from regenerative economic theories, notably Fullerton's 8 Principles of

Regenerative Capitalism (Carbon Copy, 2024). Second, ReFi is recognised as a digital-first movement that capitalises on Web3 innovations, particularly blockchain technology, while incorporating other emerging technologies, such as the IoT and AI, to enhance climate-positive actions and create an inclusive, transparent, and accessible green financial system (Grasmann, 2022).

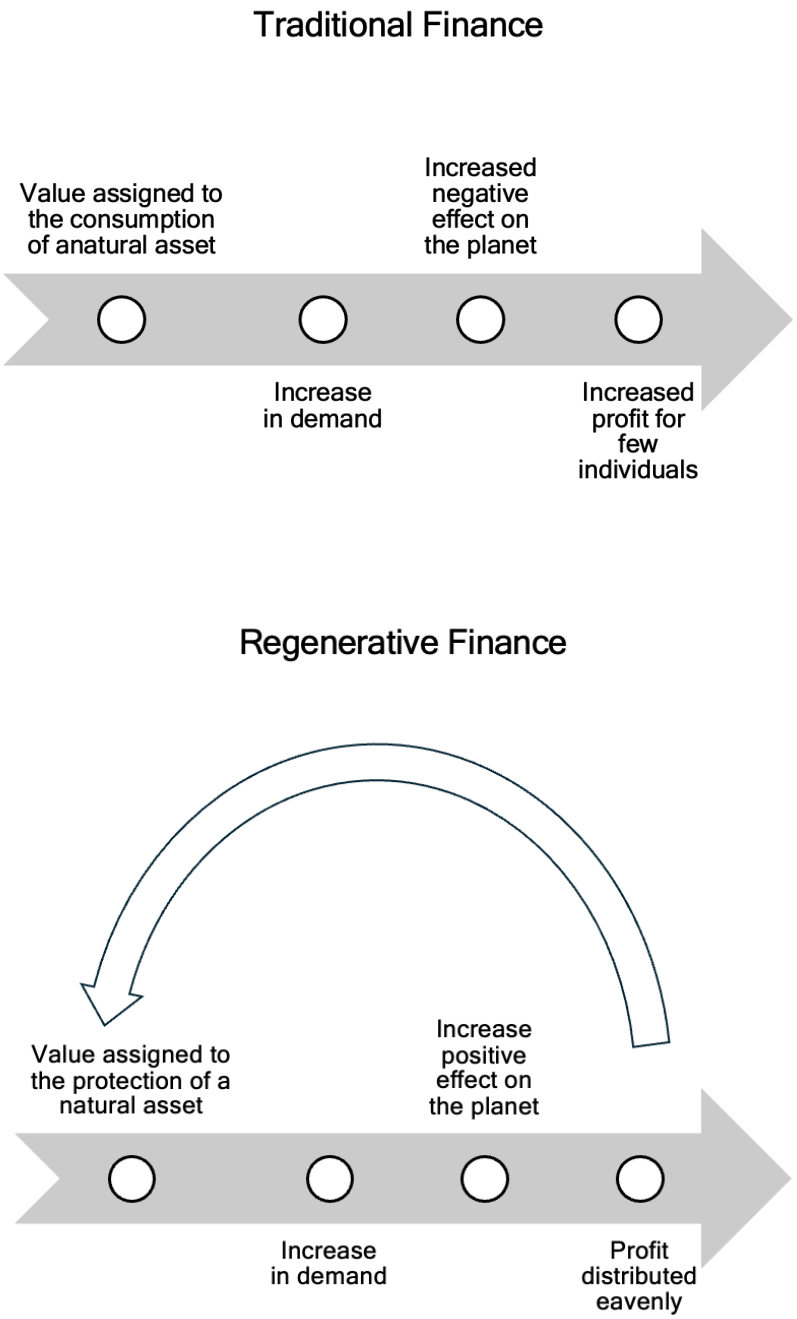

Figure 5: Adapted from Regenerative Finance vs. Traditional Finance (Toucan, 2023)

2.6.1 Web3 and Emerging Technologies

Web3 has been described as the third stage in the evolution of the Internet (Dentzel, 2023). The first stage, Web1, emerged in the early 1990s and was characterised by static, limited-functionality web pages. The second stage, Web2, represents the current internet paradigm, characterised by user-generated content and interactive platforms, but controversially marked by the significant concentration of data and information power in the hands of five major tech giants: Google, Amazon, Facebook, Apple, and Microsoft (Fenwick and Jurcys, 2022). Web3 represents a significant shift towards decentralisation, enabling users to own and control their data through blockchain technology and other innovations. More than just an evolution of the web, Web3 embodies a pronounced political narrative often called the 'web of everything and everybody.' Central to this vision is the concept and primary objective of Web3: creating a web owned and operated by its users (Buldas et al., 2022).

Web3 encompasses design attributes that can support the operability of regenerative finance instruments (Marr, 2023). It offers transparency, with transactions recorded in an unalterable database or blockchain, allowing participants to verify compliance with agreed-upon rules. Its decentralised nature ensures that no single entity can unilaterally set rules or control user behaviour without consent, allowing users to maintain independent control over their data and assets (Dentzel, 2023). Additionally, Web3 is censorship-resistant, as it lacks central authorities dictating content acceptability. This makes it universally accessible, requiring no permissions or approvals regardless of location or status. Finally, Web3 is interoperable, allowing users to build upon or integrate with existing systems without needing external approval (Toucan, 2023).

These design principles are made possible through blockchain technology, which serves as the foundational infrastructure for Web3 (McKinsey & Company, 2023). In simple terms, a blockchain is a digital ledger distributed across a network of computers. It records transactions in a series of linked blocks, with each new block building on the previous one. This structure ensures immutability because once a block is added, it cannot be altered, as all network participants receive updates simultaneously. Therefore, Web3 enthusiasts maintain that blockchain has five key attributes: immutability, accessibility, transparency, and security (Dentzel, 2023).

2.6.2 Real-world Applications

To explain the benefits of merging Web3 and other digital-first innovations with regenerative economic principles, Schletz et al. (2023) introduced the concept of a 'ReFi stack.' This stack outlines three primary use cases where ReFi leverages these technologies: enhancing NbS reporting, monitoring, and verification through digital methods (D-MRV); capital raising and trading through tokenisation and asset pooling; and establishing decentralised governance structures, such as DAOs. The various processes behind the functioning of the ReFi stack are managed through smart

contracts, which are blockchain-based automated application logic designed to ensure seamless interoperability across different computer networks. Smart contracts automatically execute transactions once all parties fulfil their obligations according to predefined rules and verification criteria (Franke et al., 2020).

2.6.2.1 D-MRV

Traditionally, MRV involves multiple steps to quantify emission reductions and other metrics from a specific NbS project, including extensive data collection, time-consuming analysis, third-party verification, and complex reporting. This process is often costly, time-consuming, and prone to errors (World Bank, 2022). Moreover, its reliance on manual data recording and in-person surveys makes it vulnerable to fraud and manipulation. D-MRV methods utilise digital data collection techniques to address these issues, such as drone-based earth observation, satellite geospatial data, and local smart sensors or IoT devices enhanced by algorithmic models or AI. These approaches improve information availability, interoperability, and transparency (CLI, 2019; World Bank, 2022; Schletz et al., 2023).

Following digital data collection, the use of blockchain for securing data on a distributed ledger can facilitate the transition to public and democratic ‘warehouses’ or ‘oracles.’ These platforms enable NbS and carbon project developers to access, validate, and share data on-chain, ensuring that the information remains both accessible and verifiable (Al-Breiki et al., 2020; Mammadzada et al., 2020). This approach enables various institutions and stakeholders to coordinate and adopt mutually beneficial standards, reducing data collection and transaction costs and minimising gaps and overlaps (Abbott, 2014). Furthermore, decentralised D-MRV platforms reduce green finance's dependence on costly and bureaucratic centralised standard registries, such as Gold Standard or Verra. This shift empowers smallholder farmers and Indigenous communities to generate, verify, and commercialise new nature or social impact credits (Climate Collective, 2022).

For instance, ReFi’s initiative, Regen Network, has developed the Regen Registry, an open-source platform designed to facilitate cost-effective and comprehensive D-MRV. Their mission is to democratise green finance by enabling communities of earth stewards, scientists, technologists, and climate entrepreneurs to use publicly available data to create new forms of ecological assets (Linggih, Bryant, and French, 2023). A notable example is how the Sharamentsa Indigenous Community in Panza, Ecuador, were able to create biocultural credits through Regen public data to protect and monitor a critical 10,000-hectare jaguar habitat (Regen Network, 2024). This case exemplifies how Web3's principle of ‘universal accessibility’ through D-MRV is applied in ReFi, challenging traditional standards and empowering Indigenous communities to participate in nature markets. It also aligns with regenerative capitalism principles, such as ‘honouring place and community’ and ‘empowering participation’.

2.6.2.1 Funding and Trading through Tokenisation

Tokenisation can significantly enhance transparency in green finance by creating digital representations of carbon, biodiversity, and other instruments that are recorded and traded on a blockchain ledger (Schletz et al., 2023). This process draws on nature's commodification by converting tangible and intangible assets, such as renewable energy generation, land rights, or cultural heritage, into digital tokens. These tokens contain immutable metadata, including the metric, issuing country, project name, and generation year (Valdivia & Poblet, 2022; García; Franke et al., 2020), making them highly reliable. Tokens can be categorised as fungible tokens, which are interchangeable with another token of the same type, and NFTs, which are unique representations of specific assets. NFTs can represent a wide range of assets, from digital versions of financial instruments like stocks and bonds to non-financial assets such as art, real estate, and land ownership certificates (Idelberger and Mezei, 2022).

Consequently, by tokenising nature using blockchain capacities, it is possible to create a record or digital asset containing sensitive climate or social-related information, ensuring that the data remains unchanged, secure and verifiable over time. The public attribute of blockchain networks also ensures the traceability of token states and transactions, enhancing transparency and streamlining processes (Voshmgir, 2019). This process may foster increased trust and auditability, particularly in carbon markets where corruption or distrust exists (Greenfield, 2023), while ensuring verifiable digital ownership as assets evolve or change hands. Therefore, the commercialisation of on-chain tokens on trusted digital trading platforms could expedite resource allocation to regenerative initiatives by reducing intermediaries, transaction times, and costs while ensuring secure cross-border operations (Valdivia & Poblet, 2022).

Moreover, tokenisation enables the 'fractionalisation' of assets by dividing large, often premium-priced digital nature financial instruments into smaller, more affordable units or tokens. This attribute seeks to increase liquidity and promote climate-related funding by attracting a diverse range of non-institutional buyers, consistently leading to a more accessible market (Persson, Buenadicha and Gómez, 2023). Indeed, the entire ReFi movement has gained momentum due to this phenomenon (Dentzel, 2023). The Toucan Protocol has transformed a substantial amount of legacy or off-chain carbon credits into on-chain BCT tokens (Watson, 2022). Instead of being tied to specific projects, these tokens are combined, creating larger 'pools' designed to stabilise prices and enhance market efficiency (Hartley and Rennie, 2022). This approach has supported over $4 billion in carbon credit trading volume, accounting for 85% of all digital carbon credits (Braithwaite, 2024).

In Latin America, Moss Earth is converting traditional REDD+ credits from the Amazon rainforest into reserve assets to create MCO2 tokens, which users can buy, trade, or

retire (Moss Earth, 2020). Additionally, Moss Earth can pre-issue MCO2 tokens to finance NbS projects before completion (Teixeira & Asher Schapiro, 2022). This approach helps scale new forest conservation initiatives in the region. Once the project is completed and the actual carbon offsets are verified, a smart contract allows token holders to sell their tokens or receive the equivalent amount in carbon credits.

These and other tokenisation use cases have drawn significant attention from major traditional carbon registries. For instance, ACR and Gold Standard have announced plans to explore the development of digital tokens to represent carbon credits. Similarly, Verra launched an open consultation on 'Third-Party Crypto Instruments and Tokens' (Toucan, 2022) to investigate how blockchain technologies could enhance their services. Although widespread adoption of tokenisation may not resolve the fundamental issue related to commodification and 'fetishisation' of nature, it demonstrates the potential for mitigating problems like double-counting and fraud in carbon markets. Additionally, tokenisation could enhance liquidity and increase global participation in green markets.

2.6.2.3 DAOs

The final component of the ReFi stack is the DAOs. These are member-owned digital communities with decentralised governance built on Web3 principles, tokenomics, and smart contracts (Loannis and Pantelidis, 2024). Initially, the community develops and establishes the DAO's principles and rules, including voting rights and resource management mechanisms, which are then encoded in smart contracts to ensure automatic enforcement and transparent governance (Santana and Albareda, 2022). Tokens are fundamental to DAOs, representing an individual's stake and membership within the organisation, similar to stocks in traditional corporations. Moreover, token holders are usually granted voting rights and the ability to participate in the governance processes (Finck, 2018).

DAOs' decentralised governance capability seeks to address the inefficiencies, opacity, and corruption often found in traditional organisational decision-making (Wright and De Filippi, 2015). By replacing the reactive procedural security of current legal and contractual systems, DAOs reduce management costs and decision times through process automation and eliminating intermediaries. Additionally, they mitigate the principal-agent dilemma by adopting a non-hierarchical governance model that combines computational code, behavioural economics, and game theory (Voshmgir, 2019; Guskow Cardoso, 2023).

Despite having governance rules encoded on the blockchain, DAOs still heavily rely on off-chain mechanisms for ongoing issues such as rule adjudication and conflict resolution. Effective management of these analogue processes is essential to avoid problems like forking, where the community splits into factions with differing views

(Schletz et al., 2023). Additionally, many DAOs fail to deliver on their decentralisation promises, often replicating traditional organisational power imbalances (Jirásek, 2023; Axelsen, Jensen and Ross, 2022). For example, large DAOs may suffer from low community engagement in decision-making processes and the concentration of power among a few influential token holders (Bellavitis, Fisch, and Momtaz, 2022; Zhao et al., 2022).

This suggests that the 'DAO' label is sometimes more rhetorical, used to attract users rather than reflect true decentralisation. Therefore, it is crucial to rigorously evaluate each DAO's governance structure and practices (Bassi and Bandirali, 2023). Nevertheless, 'impact' DAOs such as Proof of Humanity DAO, GoodDollar, and Gitcoin DAO have been successfully implemented in managing different use cases, ranging from humanitarian aid to ecological asset markets, demonstrating both their effectiveness and potential for scalability (Jirásek, 2023).

To better understand DAOs as a central component of the ReFi ethos, it is helpful to view them as practical applications of Ostrom's (1998) regenerative theory on the governance of CPRs. CPRs, such as forests, pastures, or fishing grounds, are shared resources vulnerable to overuse and depletion, a dilemma commonly referred to as the 'tragedy of the commons' (Hardin, 1968). Historically, centralised control was considered essential for effectively managing these resources. However, Ostrom's Nobel Prize-winning research challenged this assumption. Through numerous case studies, she and other academics demonstrated that local communities could successfully self-organise to manage CPRs sustainably (Ostrom, 1992; Newig and Fritsch, 2009; Gari et al., 2017). Ostrom identified eight fundamental design principles for effective bottom-up CPR governance, including establishing clear boundaries, implementing collective-choice arrangements, and maintaining the capacity to monitor and adapt to changing conditions.

Consequently, the technologies behind DAOs have the potential to facilitate CPR governance and create new models for community-oriented environmental initiatives that address the tragedy of the commons. This is achieved by ensuring transparent and equitable governance among members through smart contracts for voting and decision-making (Poux, Filippi, and Ramos, 2020). Additionally, by accounting for and monitoring CPRs, these resources can be tokenised and integrated into shared 'liquidity pools.'

2.6.3 General Challenges

The promise of ReFi lies in integrating the principles of regenerative economics into financial systems and instruments. However, ReFi must clearly distinguish itself from traditional extractive economic models and develop practical approaches that genuinely embody the 'Re' in ReFi (Schletz et al., 2023). Disrupting these extractive

dynamics requires more than just improving information flows and coordination; it necessitates a fundamental rethinking and alteration of the core principles of the existing system. Moreover, most of the most significant ReFi projects are currently focused on commodifying and consequently tokenising carbon credits and other forms of natural assets. Thus, scholars contend that, to date, ReFi has predominantly perpetuated existing extractive logic, resulting in the commodification of nature and the reinforcement of colonialist practices (Schletz et al., 2023; Meyer et al., 2024). This issue arises from distrustful narratives about 'climate-smart blockchain platforms,' which perpetuate North-South inequalities and have a limited impact on local communities. This phenomenon is often called 'crypto colonialism' (Howson, 2020).

To fully realise their potential, ReFi models must embed regenerative and circularity practices within their core business and operational frameworks, recognising that blockchain is an enabling technology rather than a remedy for climate change. Without this essential integration of regenerative principles, persistent issues in transactional systems, such as bureaucratic inefficiencies, opacity, and double-counting, are unlikely to be addressed by simply adopting new digital technologies. These challenges may instead evolve and become further complicated by the intricacies of cryptographic algorithms, machine learning, and cybersecurity vulnerabilities in IoT sensors and decentralised ledgers (Kumarathunga et al., 2023).

Additionally, while blockchain technology presents a promising framework for innovative and participatory governance, its decentralisation and openness could establish a paradox. It may enable inferior or fraudulent ReFi projects with low-quality natural credits to overshadow genuine climate-positive initiatives (Hartley and Rennie, 2022). To mitigate this risk, the ReFi movement must establish industry standards and cultivate cooperative networks among projects (Meyer et al., 2024).

Consequently, to achieve maximum collaboration and scalability, ReFi practitioners and entrepreneurs must bridge the gap between 'crypto savvy' and 'non-crypto' audiences by developing user-friendly and easily understandable models. Engaging traditional climate audiences, such as scientists, engineers, and researchers, is also crucial (Hartley and Rennie, 2022; Schletz et al., 2023). This effort is particularly important given the recent controversies in the 'crypto' industry, including scandals, catastrophic company collapses, declining cryptocurrency valuations, and reduced funding levels, which have damaged the overall perception of blockchain technology (Johansson, 2022; Carbon Copy, 2024). Consequently, the ReFi movement faces the additional challenge of securing support from multilateral organisations, banks, governments, and corporations to scale ReFi projects and effectively achieve a significant global impact.

Additionally, the ecological impact of blockchain technology has become a controversial area in the last few years, identified in numerous academic studies (Atkins et al., 2021), industry reports (Bendiksen and Gibbons, 2019) as well as public

and government reports (OSTP, 2022). Nevertheless, for many ReFi community members, blockchain technology's energy consumption can be solved by transitioning from PoW to PoS (Wendl, Doan and Sassen, 2023). PoW relies on ‘miners’ to validate transactions by solving complex algorithmic problems. This system operates as a competitive environment where only the first miner to solve the puzzle receives a reward in the form of native cryptocurrency. Thus, miners employ high-powered computers that consume substantial amounts of energy to function effectively and remain competitive (Kalnoki, 2022).

In contrast, the PoS method rewards validators based on the amount of cryptocurrency they stake as collateral rather than the computational power they use. This seemingly minor change significantly reduces the energy consumption associated with blockchain activities. Since PoS does not require extensive computer power to function effectively, it allows for more transactions to be validated with much lower energy usage than the PoW mechanism (Hartley and Rennie, 2022). Therefore, most ReFi projects are currently being developed on blockchains that utilise less energy-intensive consensus mechanisms and protocols, such as Celo, Polygon, and Ethereum, reducing the energy footprint by nearly 99.95% (Beekhuizen, 2021). To illustrate these advancements, organisations such as BICOWG were established to address blockchain’s reputation as an energy-consuming technology and to coordinate climate-positive efforts within the sector (Schletz et al., 2023).

Despite ReFi’s operability interrogations and unsolved challenges, the urgent environmental crises the world faces today necessitate a radical rethink of economic models by both corporate and governmental bodies to move away from climate-destructive practices. Therefore, a more forward-thinking paradigm embracing the active regeneration of ecosystems is essential. There is an international consensus that climate change mitigation will require far-reaching technological changes in the energy sector and other areas, including finance (Grubb, 2004). Thus, ReFi and other technology-driven movements should be encouraged. These movements suggest a shift from a mindset of culpability and remediation to one of opportunity and value creation, potentially offering the most viable solution for regenerative development.

2.7 Colombia’s Ecological Landscape and Environmental Policies

Colombia is the second most biodiverse country in the world and the first per square kilometre (Ritchie, 2023). With only 0.7% of the Earth’s land surface, Colombia contains more than 10% of the known terrestrial biodiversity of the planet (ICI, 2024). There are more bird, amphibian, butterfly and frog species in Colombia than in any other nation (WWF, 2017). The country is distinguished not only by its abundant natural resources and diverse ecosystems but also by its rich ethnic and cultural heritage, with over 170 Indigenous and ethnic communities (Jordan, 2023). The country encompasses a variety of landscapes, including forests, two coastlines

(Pacific and Atlantic), jungles, deserts, wetlands, mountains, and moors. Furthermore, Colombia's ecological richness and substantial renewable energy potential, combined with its pioneering green taxonomy, the first of its kind in the Americas, has attracted international climate scientists, entrepreneurs, and institutions (Climate Bonds, 2022; Escobedo, 2022), making it an ideal location to explore the advancement and potential of ReFi.

2.7.1 Nature, Peace-making and Conservation

Colombia has endured decades of internal conflict and widespread displacement, which has significantly impacted the country's development. Ranking third in the world for IDP, Colombia is surpassed only by Syria and the Democratic Republic of Congo (IDMC, 2021). The conflict has resulted in more than 450,000 deaths and the displacement of over 3.6 million people (2, 2022), mainly from rural communities. Additionally, the rise of illicit activities such as coca plantations and illegal mining has severely damaged the country's environment (Suarez et al., 2016).

The paradox lies in the fact that while the conflict has exacerbated environmental degradation and hindered rural development, it has also inadvertently led to the conservation of some of Colombia's most unique and essential ecosystems. The prolonged civil war has prevented extensive exploitation of these areas due to their inaccessibility and insecurity. As a result, ecosystems such as the high Andean moorlands known as 'paramos' and parts of the Amazon and Choco rainforests have been preserved (Davalos, 2001). Moreover, scholars such as Canavire-Bacarreza, Diaz-Gutierrez and Hanauer (2018) found that municipalities located near conservation parks or reserves designated by the government before 2002 experienced a significant increase in guerrilla attacks and heightened poverty.

Moreover, after the 2016 peace agreement between the FARC guerrillas and the Colombian government, abandoned 'war' territories have become highly vulnerable to various old and new opportunistic illegal actors (Guasca, Vanneste and Van Broeck, 2022). These include guerrilla groups such as the ELN and FARC dissidents, neo-paramilitary organisations, and criminal gangs known as 'Bacrims,' all violently competing for control of extensive territories and lucrative illicit industries (Maher and Thomson, 2018). These illegal entities clash with, or sometimes collaborate with, multinational actors in the mining, oil, palm oil, agriculture, ecotourism, timber, and construction sectors, all aiming to dominate new lands for titling and exploitation. Surprisingly, Colombia's peace-making process has triggered a 44% increase in deforestation after the peace agreement was signed (McClanahan et al., 2019), highlighting the importance of implementing environmental policies to support the country's social transition (Prem, Saavedra and Vargas, 2020).

2.7.2 Green Taxonomy and Policies

In April 2022, Colombia achieved a significant milestone by becoming the first country in America to establish a national green taxonomy (Ramirez, Velázquez and Vélez-Zapata, 2022). This framework categorises economic activities according to their impact on specific environmental objectives, making it easier for lenders and borrowers to identify sustainable investments (World Bank, 2022). The taxonomy is intended to encourage public and private capital to be directed towards Colombia's environmental priorities. It recognises a local approach towards land use and agriculture, as they represent one of the most significant economic and pollution-heavy sectors. Additionally, Colombia was one of the first countries to establish a multi-sector MRV framework, developing an online platform and implementing a management strategy across various governance levels, including both public and private sectors (Transparency Partnership, 2019).

With these policies, Colombia has established itself as a forward-thinking leader in the fight against climate change by integrating ESG criteria into public investment and adopting a green taxonomy that aligns with international sustainability standards and agreements (Ramirez, Velázquez, and Vélez-Zapata, 2022; Morcillo and Arocha, 2023). The country has also designated 30% of its land and waters as conservation areas (Conservation International, 2022). To achieve a 51% reduction in greenhouse gas emissions by 2030 and a carbon-neutral economy by 2050, Colombia has set ambitious NDCs with 196 initiatives (UNEP, 2021). To support these goals, Colombia has enacted and implemented four pivotal laws: the Clean Transport Act, the Environmental Crimes Act, the Energy Transition Act, and the Climate Action and Decarbonization Act (World Bank, 2022).

Colombia has been actively engaged in carbon markets since the Kyoto Protocol's inception in 1997, consistently supporting global market-based mechanisms to achieve climate goals. The country has also participated in various international carbon market initiatives, such as the World Bank's Program for Market Readiness (SPAR6C, 2024). Domestically, Colombia has introduced carbon pricing and market instruments to encourage voluntary mitigation projects, including two national carbon standards: CERCarbono and BioCarbon. In 2016, Colombia implemented a carbon tax to incentivise sustainable practices, allowing private entities to offset this tax by using domestic carbon credits. This approach has spurred the development of over 110 active NbS and voluntary carbon market projects (Climate Focus, 2022).

Although Colombia has implemented robust green policies, there is still a disconnection between national mandates and their implementation and oversight at the regional level. This detachment is exacerbated by historical corruption issues that have affected the Colombian government's performance (Pring and Vrushi, 2019; Školník, 2020; Oviedo, 2022), resulting in resource constraints and challenges in project execution (Climate Action Tracker, 2023). Unfortunately, corruption is notably

prevalent in regional entities responsible for environmental affairs (Tarazona, 2022). NGOs such as Carbon Market Watch and the CLIP (2021) have published reports highlighting the inefficiency of the Colombian Ministry of Environment in implementing carbon policies. These reports indicate that two large-scale carbon projects overstated their emissions reductions and generated fictitious credits, which oil companies purchased to comply with national carbon tax legislation. This resulted in millions of dollars in losses for the government (Stoefs, 2021). Additionally, the CLIP noted: 'This case demonstrates that, although Colombia has been a pioneer in creating financial incentives for communities to preserve valuable forests, the system has significant shortcomings. The government is not effectively overseeing it, and there is a lack of transparency and traceability (Dufrasne, 2021).

2.7.3 ReFi in Colombia

The complex current landscape in Colombia, marked by its rich biodiversity, ongoing peace-making and social fabric reconstruction processes, and the institutional gaps between ambitious green policies and their implementation, has captivated national and international scientists and entrepreneurs, including those committed to regenerative movements. Consequently, the domestic ReFi ecosystem has begun to emerge over the past three years. Although exact numbers are not available, it is estimated that between 10 and 20 projects have been established with the aim of regenerating the country's unique ecosystems, improving the well-being of local communities, and bridging the technological and information gaps that exist (CFA, 2021) to build resilience through NbS.

Some of these entrepreneurs work independently, while others are part of conglomerates or 'nodes' within the global ReFi DAO, located in major Colombian cities like Medellin and Bogota (ReFi DAO, 2024). They employ a variety of business models, ranging from generating gold-tokenised liquidity pools to prevent mining to creating biodiversity credits using Indigenous MVR methodologies. These initiatives will be investigated in the upcoming comparative case study.

3. Methodology

3.1 Research Design

The comparative case study method was chosen as the primary research methodology for this qualitative study because of its proven ability to empirically test existing theories and develop new conceptual understandings of the phenomenon under investigation (Eisenhardt, 1989; Maxwell, 2013). Comparative case analysis has been widely used in political science research, aiding in the understanding of complex economic behaviours and emergent social movements (Dion, 1998), such as the emerging regenerative movement. This approach is particularly valuable in contexts where the framework's boundaries are not clearly defined, as is the case with

ReFi, which has primarily been shaped by media narratives and isolated case studies (Meyer et al., 2024).

Furthermore, comparative case studies are particularly effective in situations where data is scarce or fragmented, as they allow researchers to derive meaningful insights from real-world contexts by identifying and analysing causal patterns across cases with shared objectives or characteristics (Yin, 1998; Goodrick, 2014). This methodological advantage aligns seamlessly with the specific aims of this research, which intended to uncover implementation challenges and success factors (patterns) and determine whether the anticipated benefits, such as improvements in community well-being and the promotion of more participatory NbS (common objectives), are being realised in ReFi projects across Colombia. Additionally, the selection of multiple cases in various regions intended to build a generalised analysis of the movement's progress within the nation.

Additionally, this research incorporated potentially significant variables identified through a detailed literature review, including the hypotheses of regenerative capitalism and the narratives of the ReFi movement as presented in various digital reports (Carbon Copy, 2024; Kumarathunga et al., 2023; Hartley and Rennie, 2022). This approach combines deductive and inductive reasoning, enabling a practical ‘reality check’ (Krishnamoorthi and Mathew, 2018) where the case study findings could be contrasted with the emerging theoretical assumptions. Ultimately, the design of this research is meant to validate the potential of ReFi as a transformative economic and social movement, as has been proposed in recent years. It also provided insights into the causal factors that may either promote or hinder the development of a more effective, sustainable, and regenerative financial framework.

3.2 Data Collection

Semi-structured interviews were chosen as the primary data collection method because they are particularly effective for obtaining in-depth, nuanced information from participants, allowing for open-ended questioning and exploring underlying meanings and motivations (Adams, 2015). This approach was critical given the exploratory nature of the research, which aimed to understand the ‘how’ and ‘why’ behind the decisions and actions of ReFi founders and practitioners. Additionally, the interpersonal and interactive style of semi-structured interviews fostered a conducive environment (Arksey and Knight, 1999; Brinkmann and Kvale, 2018) in which interviewees felt comfortable sharing their genuine impressions on sensitive topics such as structural challenges facing ReFi scalability and the role of public institutions and international agencies in promoting or obstructing the movement’s progress. This data gathering was essential because minimal research has systematically interviewed entrepreneurs and practitioners in this field (Meyer et al., 2024).

All interviews were conducted via video conferences and began by establishing the context of the academic research, clearly articulating the motivation and objectives, and ensuring the confidentiality of all information shared. Each participant was informed about the recording of the interview, and their consent was obtained. Interestingly, all participants expressed that they were unconcerned about anonymisation or the use of pseudonyms. In fact, the majority expressed a strong desire to have their organisations named to promote their work and the broader regenerative movement in Colombia. The interviews adhered to the best practices of the case study, structuring a questionnaire (Appendix C) to progress from general to specific topics (Adams, 2015). It started with open-ended, non-sensitive questions aimed at gaining a general understanding of each ReFi initiative's context and each interviewee's professional profile.

Subsequently, more targeted and technical questions were posed regarding the main challenges encountered during the implementation and operation of their projects or business models and the role that Web3 technologies played in their design and success. The interviews then transitioned into more sensitive areas, such as the current state of ReFi in Colombia, examining the impact of the Colombian government, as well as non-profit and international institutions, on shaping the movement. Following this, a series of targeted questions were asked about community impact, specifically exploring whether and how their initiatives were affecting communities and what metrics could be developed to measure these impacts. At the end of each interview, participants were asked about their vision for the ReFi movement, encouraging them to reflect on its long-term implications and potential evolution. This aimed to capture their aspirations, expectations, and perceived challenges that might shape ReFi's future trajectory.

3.3 Sample

A purposive, non-probabilistic sampling technique was employed to capture a range of perspectives within the Colombian ReFi ecosystem. This approach was chosen because the study's objectives required including specific groups or individuals with knowledge or relevant perspectives to answer the research questions. Thus, the sample was deliberately selected to include participants who could provide the most appropriate and insightful contributions (Mason, 2002; Robinson, 2014).

The research incorporated three distinct groups of interviewees: founders of specific ReFi initiatives or startups focused on funding regenerative projects within targeted communities; founders of national or regional ReFi gremial associations; and non-ReFi climate experts closely connected to the development of regenerative movements in Colombia. The inclusion of this third group aimed to enrich the understanding of the broader ecosystem by providing external insights that contributed to the objectivity and

credibility of the research, enhancing its academic rigour and balancing the data obtained from ReFi practitioners.

The organisations led by founders in the first two categories were selected as the comparative case studies. Although their structures and operational models may vary, the research criteria focused on evaluating the initiative's ability to impact local communities' well-being, identifying common implementation challenges, and understanding the movement's overall development across the nation. Thus, all initiatives were included in the multi-case study, whether for-profit or non-profit, and whether their goal was to fund specific projects or support the overall growth of the ecosystem.

After identifying these categories, the first ReFi organisation was located through online investigation. Upon successfully contacting the founder and conducting a semi-structured interview, a snowball sampling technique was subsequently employed. This sampling method leveraged the social connections, in this case from the initial interviewee, to identify and reach further potential participants (Naderifar, Goli and Ghaljaei, 2017). Snowball sampling proved particularly advantageous, given that the ReFi community in Colombia remains a niche area with limited publicly accessible information. Using purposive and snowball sampling methods, eight interviews were conducted, including four with ReFi individual initiatives founders, two with gremial or 'node' founders, and two with non-ReFi climate professionals. This process resulted in the consolidation of six case studies.

Case 1: Koko DAO

Koko DAO is an organisation based in Huila, Colombia, founded by Ana María Mahecha and dedicated to preserving 400 hectares of endangered native forest through the emission of on-chain credits to avoid deforestation (Gitcoin, 2024). The startup collaborates with rural communities and small landowners who typically lack the resources or sufficient land to participate in carbon market forest preservation schemes. Koko DAO leverages satellite data and geospatial models by utilising the Gain Forest open-source D-MRV oracle, enabling small-scale conservation projects to generate affordable ecological credits. In addition to its conservation efforts, Koko DAO provides employment opportunities for community members, offering equitable compensation for their contributions to protecting and restoring nature. The organisation also provides training programs in regenerative agriculture, empowering communities to build sustainable futures.

Case 2: Alternun

Alternun, a company co-founded by Noach Kettler Yakowitz and José Santiago Gómez, offers a novel approach to the gold mining industry by eliminating the need for physical extraction. Alternun's core idea is to eliminate the need for gold extraction,

which typically leads to environmental harm and community displacement, by finding alternative ways to verify and account for gold reserves. Considering that 90% of extracted gold is currently used merely as a store of value (Ross, 2024), Alternun has developed a model that uses blockchain technology to verify and tokenise these gold reserves underground while maintaining the ecosystem's health. This methodology creates ‘liquidity pools,’ where investors can benefit from the fluctuating value of tokenised gold while earning profits by funding regenerative projects like solar farms and agroforestry on the land above the unextracted reserves (Escarraga, 2023). All decisions are managed through a DAO, promoting a more sustainable and equitable distribution of resources.

Case 3: Savimbo

Savimbo, founded by Dr Drea Burbank, is an initiative based in the Putumayo region of the Colombian Amazon. It focuses on creating a conservation economy that supports small farmers and Indigenous communities in their efforts to protect forests and wildlife. The company's mission is to enhance the climate market participation of these groups by offering salaried or pre-paid conservation and reforestation activities, which then generate biodiversity credits that can be sold for shared profits.

These biodiversity credits are secured and traded on the blockchain, representing one hectare of fully conserved biodiversity hotspots. Each credit is verified by photographic or video evidence, ensuring transparency and accountability. This initiative focuses explicitly until this moment on safeguarding ecosystems within a jaguar corridor, a region home to rare and endangered species such as harpy eagles, spectacled bears, and jaguars. Savimbo emphasises the integration of tradition with modern technology, describing its approach as a ‘digital handshake’ between the past and the future, ensuring that the conservation efforts of local guardians are recognised and rewarded.

Case 4: The Barichara Regeneration Fund (BRF)

The BRF was founded by Joe Brewer, one of the first regenerative enthusiasts associated with the Capital Institute. The fund focuses on restoring a 500,000-hectare area in the Northern Andes of Colombia, particularly within the High-Andes tropical dry forest ecosystem. The initiative addresses ecological challenges such as deforestation, soil degradation, and biodiversity loss by integrating holistic ecological, social, and economic community efforts. A significant aspect of the BRF’s approach is the creation of community participatory structures to manage the collected funds. Web3 technologies are employed to raise capital for local projects and monitor environmental health (Gitcoin, 2023). The BRF supports various projects within this bioregional framework, including efforts in syntropic agroforestry, community reforestation, and cultural education.

Case 5: ReFiDAO Medellín

ReFiDAO Medellín is Colombia's first regenerative finance node within ReFiDAO, the world's largest network of regenerative initiatives. The DAO, co-founded by Tereza Bízková and Juan Giraldo, focus on fostering community-driven incubation programs, investments, and dialogues around Web3-enabled regenerative-oriented innovations (ROIs). ReFiDAO Medellín aims to address the most pressing socio-economic and environmental challenges within the city and the surrounding regions. This includes poverty, inequality, youth unemployment, land degradation, and limited access to essential resources such as energy, water, sanitation, housing, and education by advancing climate-positive practices and sustainable solutions (Chen, 2023).

Case 6: ReFiDAO Bogotá

Bogota's DAO node, founded by Yesica Garcia, promotes regenerative finance and Web3 technologies in the Colombian capital and the Cundinamarca region through collaboration, education, and community engagement. Focused on fostering sustainable financial and environmental practices, ReFiDAO Bogotá organises educational events, workshops, and reforestation projects that raise awareness about the transformative potential of blockchain, tokenisation, and Web3 (ReFiDAO, 2023). The node aims to build a diverse, collaborative community of experts and innovators dedicated to addressing social and environmental challenges while contributing to a more equitable and sustainable local community.

Non-ReFi Interviewees

As mentioned, two additional non-ReFi climate experts were interviewed. First, Dr Evert Thomas, affiliated with the CGIAR, focuses on the conservation and sustainable use of forest genetic resources across Latin America, including Colombia. His work involves developing advanced online tools for agroforestry systems to improve native cacao and Amazon nut genetic resources for tree-based restoration. At the time of the interview, Dr Thomas was exploring the development of on-chain biodiversity credits as a potential funding mechanism for his projects.

Second, Diego Chaparro is a senior associate at CO2CERO, a 12-year-old Colombian carbon project company specialising in sourcing and developing projects such as REDD+, small hydro, and mangrove conservation. CO2CERO commercialises carbon credits in international voluntary markets and Colombia's domestic carbon tax. While CO2CERO has traditionally operated within conventional carbon market structures, similarly to Dr Thomas, Chaparro was exploring using carbon tokens and NFTs as innovative advancements for his organisation.

Participant Name	Role	Organization	Code
Ana María Maecha	Founder and CEO	Koko DAO	F1KD
Noach Kettler	Co-founder and COO	Alternun	F2AN
Dr. Drea Burbank	Co-founder and CEO	Savimbo	F3SV
Joe Brewer	Co-founder	BRF	F4BRF
Tereza Bizkova	Co-founder	ReFiDAO Medellín	F5RDM
Yesica Garcia	Founder	ReFiDAO Bogotá	F6RDB
Dr. Evert Thomas	Senior Scientist	CGIAR	EX1CG
Diego Chaparro	Global Sales Lead	CO2CERO	EX2CC

Figure 6: Participant Name Coding Table

3.4 Data Analysis

Following data collection, reflexive thematic analysis was employed to identify patterns or themes within the data (Wæraas, 2022). The flexibility of this method made it particularly well-suited for this research, allowing it to function both as a realist approach, capturing actual events and experiences directly linked with the founding and scale of ReFi initiatives, and as a constructionist approach, exploring how broader societal discourses shape these realities (Braun and Clarke, 2006). This dual perspective facilitated a critical comparison between the emerging narrative of ReFi and the realities observed in the interviewee's testimonials.

During the encoding of data from the video call transcriptions, an inductive approach was applied to allow themes to emerge from the data. In this study, the codes were not grouped based on semantics but rather by inferring that they shared a similar meaning, 'value' or 'latent coding' (Byrne, 2022). As a result, manual coding was necessary as the data required a more creative and active approach than using software. This decision enabled the identification of nuances and patterns that would not have been evident if only semantic matches had been considered. After completion of the analytical process, six themes and twelve subthemes were constructed (Appendix D) to illustrate the findings.

4. Findings

4.1 Regulatory and Institutional Barriers

All ReFi founders identified institutional and regulatory barriers as significant challenges. The primary barrier was the generally negative perception of cryptocurrencies and the Web3 ecosystem. This perception has impeded investment and collaboration efforts between ReFi projects and Colombia's international multilaterals, NGOs, and local government agencies. Participant F1KD highlighted these challenges:

> *One of the major challenges here is that our natural allies, such as NGOs like UNICEF, various environmental organisations, and United Nations investment*

> *funds, should ideally be supportive. However, from personal experience, I can tell you that they are hesitant to get involved. They prioritise their brands and reputation above all else, and they don't want to be associated with crypto because they don't understand it. They only hear about scams and negative aspects. Consequently, approaching what should be our natural allies has been difficult. This is also reflected in the Colombian government's lack of interest in focusing on partnering with us.*

The second identified barrier relates to the predominant carbon markets, which are governed by exclusionary institutions that appear to resist alternative models, such as on-chain biodiversity and tokenised credits. These large registries seem uninterested in, or actively lobby against, adopting decentralised or locally driven approaches to generating carbon credits. As F3SV expressed:

> *They're making things as difficult as possible. I've heard Verra charges intermediary fees, and the ones paying Verra exploit our population. Most of Verra's funding comes from large, centralised farming and logging companies. They don't work for us. They've been quite combative on the global stage, attempting to push us out of business in various ways.*

The third barrier identified by all interviewees, including non-ReFi founders, is the presence of institutional voids in Colombia. These voids stem from the absence of the Colombian state in regions where ReFi initiatives are being implemented, obstructing the formation of public-private collaborations crucial for effective community management and resource mobilisation. This lack of state involvement also increases security and operational risks for ReFi founders and their collaborators due to the ongoing armed conflict and the activities of illicit organisations in high-biodiversity areas.

Participants F2AN, F4BRF, F5RDM, and EX1CG discussed their experiences engaging with local rural governments and central authorities in Bogotá and Medellín. Although these interactions were generally cordial, the founders expressed frustration over the lack of follow-through on actionable commitments. Despite these challenges, F4BRF highlighted an opportunity within these institutional voids:

> *Colombia is a paradox: it has really good legal structures but very poor legal enforcement and implementation. There's also a significant lack of cultural capacity to carry out that implementation. However, if Colombia's cultural strengths could be better organised, they could be absolutely transformative. I know very well that Colombian institutions are weak, and that's exactly why I believe this change can happen here. Regenerative models often emerge after a collapse, much like the cultural renaissance that took place in Detroit after its industrial economy collapsed in the 1990s.*

4.2 Economic Model and Market Viability

The founders of the studied cases expressed widespread concern about the challenge of developing profitable or economically sustainable models. Koko DAO, BRF, ReFiDAO Medellín, and ReFiDAO Bogotá rely entirely on institutional donations or peer-to-peer contributions via Web3 platforms, while Savimbo and Alternun partially depend on these sources of support. This reliance is primarily driven by difficulties in accessing or commercialising the biodiversity and reforestation credits they produce, further exacerbated by external market forces and scepticism toward tokenised instruments, as discussed in Theme 1.

Of all the initiatives, Alternun stands out as the only organisation actively pursuing a profitable model for both the company and its clients, employing strategies such as gold reserve appreciation and investments in renewable energy sources. Addressing this challenge, F1KD affirmed:

> *The issue is that it's not scalable unless we generate acceptance within regulations, for example, with companies that need to comply with things like Colombia's 15% carbon tax. If we can't integrate our solutions and technology into government and corporate requirements—like for supermarkets or other consumers—scaling is impossible. Good intentions only get you so far. Up to now, we've been funded by donations and grants, but it's not sustainable. Coming from a background where I used to sell products or services, this reliance on donations is exhausting.*

There was a consensus among interviewees that developing more financially sustainable models depends on diversifying nature assets and portfolios. These credits or tokens could be issued and verified using advanced methods like D-MRV or simpler practices such as fauna video recording, ensuring the involvement of local actors. This approach aims to reduce reliance on existing carbon credit mechanisms, which limit the scalability of ReFi models and fail to address core climate issues. Instead, the new credits would emphasise environmental resilience and social reconstruction, supporting a more holistic regenerative approach. F5RDM further elaborates on this idea:

> *I believe that the most viable ReFi use cases are still closely tied to DeFi, which seems completely natural. For centuries, we've perceived value primarily through financial lenses. Now, we're shifting towards a more holistic view of value, incorporating different forms of capital—intellectual, spiritual, community, and others. This transition is a challenge we need to work through. So far, the most successful use cases I've observed focus on creating new markets with different types of tokens. These include biodiversity tokens, like on-chain*

carbon credits. Additionally, one of my colleagues is working on a project involving impact tokens. For example, how do you tokenise or quantify something as traditionally intangible as female education, water sanitation, or even peace? She's working on projects like that.

A key subtheme in the discussion of ReFi operating models is the importance of ensuring that payments are either directly made to or shared with communities. In the case of Savimbo and Koko DAO, this manifests as direct payments to community members via blockchain-based wallets or wire transfers in exchange for their contributions to verifying nature data, engaging in reforestation, and providing other ES. Conversely, in BRF, Alternun, and the Medellin and Bogota ReFiDAOs, the focus is on establishing collective or shared funds to decide how to allocate resources democratically.

F3SV underscores the significance of these reciprocal economic relationships, particularly with Indigenous communities, highlighting how this approach has facilitated the development of her ReFi project in the Colombian Amazon. She explains:

I didn't come in as a carbon colonialist saying, 'I want to start a green business.' They approached me and said, 'We want a green economy.' So, I started using my expertise in building economies to assist them. Their focus was on economic solutions because they were adamant—and I agreed—that the primary drivers of deforestation in the Amazon are economic. They wanted a for-profit business model, firmly believing that the charitable sector fosters dependency. Globally, they viewed it as white people profiting from oil, petroleum, and mining, then donating money back when it suits them. They rejected that dynamic. Their argument was, 'We provide a global service by keeping our trees standing, and we deserve to be compensated for it.' It was a challenging request but absolutely vital. They also insisted on no strings attached, which is crucial for Amazonian businesses—no long-term contracts or restrictive conditions.

4.3 Paths for Community Prosperity

Two key benefits emerged when interviewees discussed the impact of their initiatives on community prosperity and success metrics. The first benefit, which aligns with Theme 2, is the empowerment of local populations through economic alternatives provided by ReFi. This empowerment occurs by integrating communities into carbon and nature markets, offering them new opportunities to shift away from environmentally damaging practices, such as deforestation or mining, towards regenerative practices.

These alternatives, as articulated by F1KD, go beyond mere financial payments. They emphasise the creation of meaningful work and sustainable livelihoods:

> *They're not deforesting because cutting down trees is enjoyable. No, it's a matter of necessity, hunger, and the desire to move forward. I don't believe in the concept of simply paying them not to cut down trees. Instead, you need to create jobs, generate opportunities, and inspire curiosity in people. Imagine if I told you, 'Here's 100,000 pesos a day, but don't do anything.' Obviously, that wouldn't work because, at our core, we all have a human need to be productive, to progress, to educate our families, and so on.*

Most interviewees identified the second path to impacting communities as empowering them to manage their lands and implement regenerative activities based on their ancestral knowledge or through resource and investment management. Thus, the concept of shared stewardship was found to be central to these regenerative practices. F4BRF articulates this notion through a metaphor:

> *In ReFi, we need a protective 'membrane' around a territory, allowing communities to selectively choose which resources to bring in and which to keep out. Just as a biological cell uses active transport to block toxins and seek nutrients, a community should control its own processes to promote health and well-being. This means setting its own agenda, deciding what to welcome, what to remove, and controlling the pace of change—because even beneficial things can overwhelm a community if introduced too quickly.*

4.4 Web3 enabling mechanisms

Although the interviews did not delve deeply into the technologies behind the initiatives, seven out of eight participants noted that Web3 capabilities were highly advantageous for managing and trading credits or tokens. They highlighted how Web3-based exchanges and crypto crowdfunding platforms like Gitcoin and Giveth facilitated the sale, tracking, and direct funding of their initiatives.

The perception of DAOs, however, was mixed. Founders from Savimbo and BRF viewed DAOs as largely impractical due to their high costs and complexity, which conflicted with the grassroots, community-centered approach they aimed to support. Conversely, founders of the ReFIDAO nodes in Medellin and Bogota see DAOs as crucial for operating in ReFi's ecosystem.

F1KD elaborated on this divide by distinguishing between the conceptual and technological aspects of DAOs:

In KokoDAO, we are a 'hybrid' DAO because it is very difficult to create a 100% online, decentralised DAO in rural communities. However, if you observe how these communities are organised, they are essentially DAOs in how they make decisions and vote, and they obviously don't naturally call themselves that.

4.5 Movement Expansion and Alliances

The mixed sentiment about DAOs also reflects differing views on how the ReFi movement should grow in Colombia. Some participants favour a more 'centralised' approach, which involves integrating new initiatives as nodes or directly partnering with a regional or national ReFiDAO. This model is seen as beneficial for improving coordination and providing unified access to funding opportunities. As F2AN illustrates:

For Alternun, ReFiDAO Medellín has been a great sponsor; they helped us with capital funding of 10,000 USD so that we could develop some of the platform's functionalities. They also support us tremendously by giving us visibility and inviting us to events they host, and whenever there is space for us, they always extend an invitation.

Nevertheless, for F3SV, there is a detachment with the 'regen guys' in the central nodes, who have utopian ReFi visions but are not connected to the real problems in the rural regions. Similarly, F1KD expressed her concern about the concept of nodes, thinking that this hinders the development of a differentiated brand for every startup. She also highlighted the necessity for the ReFi community in Colombia to build solutions around real problems:

In blockchain technology, we must focus on finding people with real problems who can build solutions within their region or community. Instead of creating problems that don't exist, we should identify real issues that ReFi could address and guide these people on how to solve those problems using blockchain, technology, or crypto. I see many meet-ups happening (sponsored by the ReFiDAO nodes). Still, it feels like the same people are attending without actually seeking out industries or businesses that could benefit from blockchain. It's crucial to break out of this niche and find new industries—whether it's farming, dairy production, or pharmaceuticals—that could benefit from ReFi in Colombia. Until we demonstrate real use cases for crypto in Colombia, I'm not sure we're truly making progress.

4.6 Technology and Education Gaps

Beyond the external challenges of expanding the movement nationally, two structural issues were identified in spreading ReFi concepts in Colombia. The first issue is the

complexity of the narratives. Five interviewees noted that technical language related to Web3 creates a double barrier. Firstly, this complexity dissuades potential sponsors and strategic partners, many of whom lose interest due to the abstract nature of blockchain technology. Secondly, it hinders engagement with communities that lack familiarity with blockchain, making it difficult to involve them in co-creating solutions. Consequently, founders agreed on the urgent need to 'translate' these regenerative principles and technological concepts into more straightforward language that resonates with the diverse realities of their target audiences. Effectively addressing this challenge is crucial for the broader dissemination of the movement.

Additionally, there is a lack of technological infrastructure in remote areas of the country where most initiatives aim to operate, such as limited internet access or the lack of smartphones to provide community members with blockchain-based wallets for direct payments. According to two founders, this issue cannot be resolved simply by providing communities with the necessary technology to make the operational models function. The introduction of blockchain, which could easily be misused in a country like Colombia with its history of conflict and illegal activities, could be highly counterproductive, as described in F5RDM:

> *One of my biggest worries with the crypto blockchain part is the unintended consequences. It's not just about giving people wallets and tools—we really need to make sure they have the knowledge to use them responsibly. Blockchain is great, but without proper understanding, people could easily lose their wallet codes or, worse, get scammed. Bad actors are everywhere, not just in Colombia, and that's a real risk. So, we have to think carefully about how to avoid these situations in the communities we work with. Once you're dealing with people's money and identities, the responsibility becomes huge, and we need to invest more in education to prevent these problems.*

5. Discussion

The discussion chapter critically analyses the findings. It addresses the research questions by contrasting the comparative case data scrutinised through thematic analysis with the relevant theoretical frameworks and data established in the literature review. This chapter provides insights into the current state of the ReFi movement, highlighting its challenges and examining its impact on local communities.

5.1 ReFi Advancement in Colombia

The findings indicate that Colombia's ReFi movement is still in its early stages, characterised by a limited number of active initiatives and regional nodes, with only a few hundred advocates. Despite this nascent phase, the establishment of ReFi organisations in biodiverse regions such as Barichara, Huila, and Putumayo, where rural and Indigenous communities are actively involved in project design and benefit-

sharing, demonstrates a genuine commitment to the principles of regenerative capitalism, such as ‘honouring community and place’ (Fullerton, 2015). Moreover, Colombia's rich biodiversity (Ritchie, 2023; International Climate Initiative, 2024; WWF, 2017) and the stewardship of its lands by local Peoples (Jordan, 2023), as highlighted in the literature review, were widely acknowledged by interviewees as unique potential drivers for further ReFi implementations.

The comprehensive utilisation of Web3 technologies across the studied cases confirms the strong interdependence between ReFi initiatives and these digital innovations. In all studied cases, the applicability of Web3 technologies closely aligns with ReFi’s technology stack proposed by Schletz et al. (2023), which includes on-chain D-MRV, funding and trading mechanisms through tokenisation, and decentralised governance. This categorisation has proven to be a highly relevant practical framework for defining the scope and functionalities of ReFi. The applications mentioned in the stack were consistently employed to support individual ReFi initiatives' operational models and to build the movement at regional and national levels using decentralised structures or DAOs.

5.2 Main Challenges

However, the collected data reveal several structural barriers that impede the broader adoption and impact of the ReFi movement. These challenges can be grouped into three main areas: perception and trust issues, the dominance of carbon markets and prevailing narratives, and the disconnect between technological narratives and local realities. Regarding trust, although cryptocurrency trading is just one application of blockchain technology, high-profile scandals, fraud, and the current volatility of Web3 ecosystems, as noted by Johansson (2022), have caused significant scepticism around ReFi. This distrust is further exacerbated by the widespread awareness that blockchain technology is energy-intensive (Atkins et al., 2021), undermining its suitability for regenerative and climate-positive initiatives. While technological advancements, such as the shift from PoW to PoS, have partially alleviated these concerns (Wendl, Doan, and Sassen, 2023), doubts about the environmental sustainability of ReFi persist, complicating efforts to strengthen its credibility.

Furthermore, the claimed benefits of transparency and inclusion in ReFi require closer examination. Kumarathunga et al. (2023) argue that the complexities of cryptographic algorithms, cybersecurity vulnerabilities, and the abstract nature of decentralised ledgers may complicate rather than facilitate green finance, a concern also raised by the interviewees. Additionally, the anonymity and lack of regulatory oversight associated with blockchain and crypto assets make them attractive to criminal networks, particularly in Colombia, where illegal activities and institutional corruption are prevalent (Pring and Vrushi, 2019; Školník, 2020; Oviedo, 2022), especially within environmental entities and transactions (Tarazona, 2022). Consequently, the misuse of these technologies poses significant risks, including money laundering, fraud, and

cross-border crime, which could undermine the intended benefits of ReFi for local communities. These concerns were frequently highlighted by ReFi founders, who emphasised the critical need for targeted awareness campaigns and comprehensive educational initiatives to mitigate these risks and ensure the responsible use of Web3 technologies within the sector.

Nevertheless, it is essential to evaluate if opposition to Web3 technologies is justified on technical, environmental, and social grounds and whether traditional entities involved in green finance exploit this distrust to hinder emerging initiatives that challenge their economic dominance and interests. Traditional carbon markets, which rely on centralised, top-down approaches and multiple intermediaries to secure financial returns, often result in profits being captured by everyone except the communities they are intended to support (Bachram, 2004; Bhambra and Newell, 2023). This contrasts sharply with ReFi's decentralised, community-driven ethos (Hartley and Rennie, 2022). Such misalignment can breed resistance, stifle innovation, and maintain the status quo in climate action, a paradigm that urgently requires transformative change, as highlighted by several scholars (Grubb, 2004; Muradian et al., 2013; González-Márquez and Toledo, 2020). The misalignment may foster resistance, suppress innovation, and preserve the status quo within the climate change paradigm, which urgently demands transformative modification, as several scholars emphasise (Grubb, 2004; Muradian et al., 2013; González-Márquez and Toledo, 2020). Moreover, data from ReFi founders indicate that this dominance is actively maintained through lobbying efforts that oppose the adoption and resource allocation to Web3 initiatives.

When well-implemented, ReFi's approach of trading new types of nature assets, such as biodiversity and social impact tokens, and improving the traceability of these trades, can offer significant benefits for green finance. Non-ReFi climate specialists interviewed in the study confirmed that this approach could mitigate harmful practices highlighted by scholars and journalists, such as carbon offsetting through monoculture plantations, double-counting, and reliance on multiple intermediaries (Lohmann, 2005; CLIP 2021). However, it fails to address the pronounced issue of commodity fetishism (Marx, 1867) and the commodification of nature and social relationships in the establishment of NbS, as emphasised by Martineau and Lafontaine (2019). As a result, ReFi may need to develop alternative use cases and operating models that rely on more than just the tokenisation and commercialisation of nature. This approach would help ensure that ReFi promotes holistic climate solutions, prioritising fundamental changes in production systems and consumption behaviours and fostering a deeper, more conscious understanding of planetary health.

While initiatives like Savimbo incorporate Indigenous practices to verify biodiversity projects, there remains a prevalent tendency, particularly among urban ReFi nodes in Colombia, to prioritise Web3 narratives in project development and emphasise the fictitious rhetoric that blockchain technology, with its 'smart capabilities', is the principal

solution to climate challenges (Howson, 2020). This approach often diverges significantly from the realities of rural communities in Colombia. On the one hand, it perpetuates exclusionary climate strategies by extending Western discourses through technical jargon, thereby reinforcing colonialist practices and maintaining power imbalances (Mignolo, 2019; Larsson and Orvehed, 2021). On the other hand, it creates barriers to scaling ReFi by obstructing the co-design of climate solutions that address local communities' needs and favouring external complex narratives over practical, community-driven problem-solving.

5.3 Impact and Metrics in Community Prosperity

This disconnect from local realities is also evident in the design of benefits and success metrics and how founders perceive ReFi initiatives' impact on communities. Essential foundations of prosperity, such as providing better economic opportunities and promoting local value creation through shared land management and democratic financial structures, are widely recognised by scholars (Moore et al., 2015) and acknowledged as desirable outcomes by founders. However, their initiatives can also support other dimensions of prosperity, including access to affordable housing, education, basic health services, and enhanced community power, voice, and sense of belonging. Despite this, ReFi initiatives often fail to map these and other prosperity dimensions and tailored metrics that reflect the specific contexts and worldviews in which they operate, a gap observed in most studied cases. Therefore, ReFi initiatives should focus not only on implementing the regenerative principle of 'creating a robust circulatory flow of resources' but also on integrating strategies that foster other forms of capital, such as intellectual and cultural capital (Roland and Landua, 2013). This can be achieved through educational programs, cultural activities, and community workshops.

Paradoxically, to bridge this disconnect, ReFi practitioners must move beyond their digital-first environments to engage directly with communities and local entities, gaining a deeper understanding of their needs and visions of prosperity and well-being. Such field engagement will facilitate the essential integration of Indigenous and rural value systems (Artaraz et al., 2021), enabling ReFi's technological functionalities to be translated into practical, community-specific solutions. This approach can also support the development of self-sustaining operational models or social enterprises less reliant on external grants by partnering with local organisations and leveraging their unique financial structures. This imperative to strengthen grassroots connections and incorporate diverse types of knowledge in ReFi was effectively articulated by F4BRF:

> *We must transform land ownership and move away from commodification and transactionalism—key economic concepts we need to reconsider. We must shift away from poverty mindsets, decolonise our thinking, and re-indigenise our approach to stewardship and care.*

6. Conclusion

This study has explored the emerging ReFi movement in Colombia, highlighting its potential impact on local communities as well as the challenges it faces regarding implementation and scalability. The research confirms that, beyond its increasing visibility in digital media and Web3 communities, ReFi projects are actively being applied in areas closely linked to climate resilience. ReFi provides sustainable economic alternatives and empowers communities to manage and care for their lands. Thus, ReFi holds promise as an alternative financial model that could significantly advance the development of innovative strategies to combat climate change. Moreover, the study validated the use of Web3 technologies in the examined cases, concluding that despite barriers related to technological infrastructure, expertise, and ethical concerns, proper use of blockchain can effectively address critical issues within the fragmented and heavily criticised carbon markets.

To facilitate the continued expansion of the movement, it is essential to address structural challenges. Therefore, ReFi advocates must pursue two parallel strategies: local engagement and institutional collaboration. At the local level, it is vital to implement strategies that educate communities about the benefits and limitations of blockchain technologies while also helping them build autonomous technical skills. Creating pathways for utilising these technologies without imposing specific technical narratives will encourage regenerative principles of creativity and participation, leading to more adaptable and resilient projects.

Simultaneously, on the institutional front, ReFi should focus on establishing partnerships with international organisations, multilateral banks, and local governments. Despite ReFi's decentralised nature, forming these alliances is crucial for elucidating the true potential of Web3, rectifying previous movement shortcomings, and garnering additional resources to support ReFi development. For the ReFi movement to scale effectively and achieve its intended impact, it must transition from relying solely on isolated donations or crowdfunding platforms to securing capital from corporations and institutional players. Additionally, ReFi practitioners are advised to partner with and leverage the expertise of NGOs and other social impact organisations. This collaboration will be crucial for designing non-economic programs and metrics for communities, thereby enhancing the overall impact of their initiatives. Thus, maintaining a constructive balance between cooperation and competition with dominant institutions and stakeholders in green markets will be advantageous.

7. Limitations and Recommendations

This study's limitations include its focus on a specific geographic context and a relatively small sample size, reflecting the nascent stage of ReFi in Colombia. To gain a more comprehensive understanding of ReFi's grassroots impact, future research should incorporate perspectives from community members directly involved in or

affected by ReFi initiatives. This approach would offer a more nuanced and objective view of how these initiatives influence local communities and help develop a practical framework for integrating community-centric metrics of prosperity.

Looking ahead, research should transition from diagnosis to theory-building to establish a clear and robust ReFi framework. Such theoretical development would enable more rigorous assessments of ReFi initiatives' effectiveness through quantitative and empirical methods. Expanding the research to include multiple countries and a larger, more diverse sample could provide a broader perspective on the global ReFi landscape. Additionally, exploring various cultural and economic contexts will enhance understanding of how ReFi principles are adapted and implemented across different settings, contributing to a more holistic view of the movement’s impact and potential.

8. References

- Abbott, K. W. (2014). ‘Strengthening the transnational regime complex for climate change’, *Transnatl. Environ. Law* 3 (1), 57–88. Available at: doi:10.1017/S2047102513000502

- Adams, W. (2015) ‘Conducting Semi-Structured Interviews’, *Handbook of Practical Program Evaluation*. Available at: https://doi.org/10.1002/9781119171386.ch19.

- Advani, A., Prinz, D., Smurra, A. and Warwick , R. (2021). ‘What is the case for carbon taxes in developing countries?’. *Institute for Fiscal Studies*. Available at: https://ifs.org.uk/articles/what-case-carbon-taxes-developing-countries

- Agrawal, R. et al. (2024) ‘Adoption of green finance and green innovation for achieving circularity: An exploratory review and future directions’, *Geoscience Frontiers*, 15(4), p. 101669. Available at: https://doi.org/10.1016/j.gsf.2023.101669.

- Ahonen, H.-M. et al. (2022) ‘Governance of Fragmented Compliance and Voluntary Carbon Markets Under the Paris Agreement’, *Politics and Governance; Vol 10, No 1 (2022): Carbon Pricing Under Pressure: Withering Markets?* [Preprint]. Available at: https://doi.org/10.17645/pag.v10i1.4759.

- Al-Breiki, H., Rehman, M. H. U., Salah, K., and Svetinovic, D. (2020). ‘Trustworthy blockchain oracles: Review, comparison, and open research challenges’, *IEEE Access* 8, 85675–85685. Available at: doi:10.1109/ACCESS.2020.2992698

- Allayannis, G. and Tenguria, S. (2009) ‘Carbon Credit Markets’, *SSRN Electronic Journal*. Available at: https://doi.org/10.2139/ssrn.1419269.

- Arksey, H. and Knight, P. (1999) Interviewing for Social Scientists, *SAGE Publications*. London. Available at: https://doi.org/10.4135/9781849209335.

- Artaraz, K., Calestani, M. and L. Trueba, M. (2021) ‘Introduction: Vivir bien/Buen vivir and Post-Neoliberal Development Paths in Latin America: Scope, Strategies, and the Realities of Implementation’, *Latin American Perspectives*, 48, pp. 4–16. Available at: https://doi.org/10.1177/0094582X211009461.

- Atkins, E., Follis, L., Neimark, B. D., & Thomas, V. (2021). ‘Uneven development, crypto-regionalism, and the untethering of nature in Quebec’, *Geoforum*, 122, 63-73. Available at: https://doi.org/https://doi.org/10.1016/j.geoforum.2020.12.019

- Axelsen, H.B., Jensen, J. and Ross, O. (2022) 'When is a DAO Decentralized?', *Complex Systems Informatics and Modeling Quarterly*, pp. 51-75. Available at: https://doi.org/10.7250/csimq.2022-31.04.

- Bachram, H. (2004). 'Climate fraud and carbon colonialism: the new trade in greenhouse gases', *Capitalism Nature Socialism*, 15(4), pp. 5–20. Available at: https://doi.org/10.1080/1045575042000287299.

- Bassi, E. and Bandirali, M. (2023) 'The Evolution of Web 3 and Decentralized Governance', in, pp. 108–129. Available at: https://doi.org/10.4018/978-1-6684-9919-1.ch007.

- Beekhuizen, C. (2021). 'Ethereum's energy use will soon decrease by ~99.95%', *Ethereum Foundation Blog*. Available at: https://blog.ethereum.org/2021/05/18/country-power-no-more

- Bellavitis, C., Fisch, C. and Momtaz, P. (2022) 'The Rise of Decentralized Autonomous Organizations (DAOs): A First Empirical Glimpse', *SSRN Electronic Journal*. Available at: https://doi.org/10.2139/ssrn.4074833.

- Bendiksen, C., and Gibbons, S. (2019). The Bitcoin Mining Network: Trends, Average Creation Costs, Electricity Consumption & Sources.

- Beschloss, A. and Mashayekhi, M. (2019) 'A Greener Future for Finance'. *Finance and Development Magazine.* Available at: https://international.vlex.com/vid/greener-future-for-finance-838455709.

- Best, R., Burke, P.J. and Jotzo, F. (2020) 'Carbon Pricing Efficacy: Cross-Country Evidence', *Environmental and Resource Economics*, 77(1), pp. 69–94. Available at: https://doi.org/10.1007/s10640-020-00436-x.

- Betz, R. *et al.* (2022) *The Carbon Mar*ket Challenge: Preventing Abuse Through Effective Governance. 1st ed. Cambridge University Press. Available at: https://doi.org/10.1017/9781009216500.

- Bhambra, G.K. and Newell, P. (2023) 'More than a metaphor: "climate colonialism" in perspective', *Global Social Challenges Journal*, 2(2), pp. 179–187. Available at: https://doi.org/10.1332/EIEM6688.

- Bhatnagar, M., Taneja, S. and Özen, E. (2022) 'A wave of green start-ups in India—The study of green finance as a support system for sustainable entrepreneurship', *Green Finance*, 4(2), pp. 253–273. Available at: https://doi.org/10.3934/GF.2022012.

- Bhutta, U.S. *et al.* (2022) 'Green bonds for sustainable development: Review of literature on development and impact of green bonds', *Technological Forecasting*

and Social Change, 175, p. 121378. Available at: https://doi.org/10.1016/j.techfore.2021.121378.

- Birch, K. (2017). 'Rethinking Value in the Bio-economy: Finance, Assetization, and the Management of Value', *Science, Technology, & Human Values, 42(3), pp. 460–490.* Available at: https://doi.org/10.1177/0162243916661633.

- Bose, A., Cohen, J., Fattouh, B., Johnson, O., & Spilker, G. (2021). 'Voluntary markets for carbon offsets: evolution and lessons for the LNG market'. *Oxford Institute for Energy Studies.* Available at: https://www.oxfordenergy.org/publications/voluntary-markets-for-carbon-offsets-evolution-and-lessons-for-the-lng-market/

- Bozmoski, A., Lemos, M.C. and Boyd, E. (2008) 'Prosperous Negligence: Governing the Clean Development Mechanism for Markets and Development', *Environment: Science and Policy for Sustainable Development*, 50(3), pp. 18–30. Available at: https://doi.org/10.3200/ENVT.50.3.18-30.

- Braithwaite, C. (2024). 'What is Regenerative Finance (ReFi) and How to Navigate This New Financial Frontier', *Onchain*. Available at: https://onchain.org/magazine/what-is-regenerative-finance-refi-and-how-to-navigate-this-new-financial-frontier/#:~:text=Regenerative%20Finance%20model.

- Braun, V. and Clarke, V. (2006) 'Using thematic analysis in psychology', *Qualitative Research in Psychology*, 3, pp. 77–101. Available at: https://doi.org/10.1191/1478088706qp063oa.

- Bridge, G. et al. (2019). 'Pluralizing and problematizing carbon finance', *Progress in Human Geography, 44(4),* pp. 724–742. Available at: https://doi.org/10.1177/0309132519856260.

- Brinkmann, S. and Kvale, S. (2018) 'Doing Interviews'. Second. 55 City Road, London. Available at: https://doi.org/10.4135/9781529716665.

- Brundtland, G.H. (1987) 'Our Common Future: Report of the World Commission on Environment and Development'. Geneva, UN-Dokument A/42/427. Available at: http://www.un-documents.net/ocf-ov.htm

- Buckley, N.J., Mestelman, S. and Muller, R.A. (2005) 'Baseline-and-Credit Style Emission Trading Mechanisms: An Experimental Investigation of Economic Inefficiency', *Repec*. Available at: https://ideas.repec.org/p/mcm/deptwp/2005-04.html

- Buckton, S.J. *et al.* (2023) ‘The Regenerative Lens: A conceptual framework for regenerative social-ecological systems’, *One Earth*, 6(7), pp. 824–842. Available at: https://doi.org/10.1016/j.oneear.2023.06.006.

- Buldas, A. *et al.* (2022) ‘Towards a Foundation of Web3’, in T.K. Dang, J. Küng, and T.M. Chung (eds) *Future Data and Security Engineering. Big Data, Security and Privacy, Smart City and Industry 4.0 Applications*. Singapore: Springer Nature Singapore, pp. 3–18.

- Bumpus, A. (2011). ‘Realizing Local Development in the Carbon Commodity Chain?’, *UN Research Institute for Social Development.* Available at: https://digitallibrary.un.org/record/739635?v=pdf

- Bumpus, A. and Liverman, D. (2008) ‘Accumulation by Decarbonization and the Governance of Carbon Offsets’, *Economic Geography*, 84, pp. 127–155. Available at: https://doi.org/10.1111/j.1944-8287.2008.tb00401.x.

- Byrne, D. (2022) ‘A worked example of Braun and Clarke’s approach to reflexive thematic analysis’, *Quality & Quantity*, 56(3), pp. 1391–1412. Available at: https://doi.org/10.1007/s11135-021-01182-y.

- Campiglio, E. (2016). ‘Beyond carbon pricing: The role of banking and monetary policy in financing the transition to a low-carbon economy’. *Ecol. Econ. 121, 220–230*. Available at: https://doi.org/10.1016/j.ecolecon.2015.03.020.

- Canavire-Bacarreza, G., Diaz-Gutierrez, J.E. and Hanauer, M.M. (2018) ‘Unintended consequences of conservation: Estimating the impact of protected areas on violence in Colombia’, *Journal of Environmental Economics and Management*, 89, pp. 46–70. Available at: https://doi.org/10.1016/j.jeem.2018.02.004.

- Carbon Copy (2024). ‘The State of ReFi: A Closer Look at Web3 Regenerative Finance’. Available at: https://carboncopy.news/reports/The%20State%20of%20ReFi%20Report%202024.pdf.

- Carbon Knowledge Hub. (2022). ‘Carbon pricing at a glance’. Available at: https://www.carbonknowledgehub.com/basics/carbon-pricing-at-a-glance/

- Chancel, L. (2021) ‘Climate change & the global inequality of carbon emissions, 1990-2020’, *Climate Change*. Available at: https://wid.world/news-article/climate-change-the-global-inequality-of-carbon-emissions/

- Chen, S. (2023). Gitcoin Grants & Local ReFi Initiatives: An Interview with Tereza Bízková of ReFi Medellín’, *Medium*. Available at:

https://medium.com/@szutungchen/gitcoin-grants-local-refi-initiatives-an-interview-with-tereza-b%C3%ADzkov%C3%A1-of-refi-medell%C3%ADn-070ee0bd7e6a.

- CLI (2019). 'Blockchain potentials and limitations for selected climate policy instruments', *Clim. Ledger Initiat,* 1–59. Available at: https://www.giz.de/en/downloads/giz2019-EN-Blockchain-Potentials-Climate-Policy.pdf.

- Climate Bonds Initiative. (2024). 'A Record Start to the Year for Sustainable Debt'. Available at: https://www.climatebonds.net/2024/06/record-start-year-sustainable-debt.

- Climate Collective. (2022). 'Emerging digital MRV tools shape a new climate information ecosystem', *Medium*. Available at: https://medium.com/@ClimateCollective/emerging-digital-mrv-tools-shape-a-new-climate-information-ecosystem-1e266df28f80.

- Climate Finance Accelerator. (2021) 'The Climate Finance Landscape - Colombia Summary', *UK Government, CFA*. Available at: https://www.pwc.com/co/es/cfa/docs/CFA%20-%20Climate%20finance%20landscape%20mapping%20-%20Colombia%20Summary%20Report%20(1).pdf

- Climate Policy Initiative (2021). Global Landscape of Climate Finance 2021. *CPI*. Available at: https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2021/.

- Conservation International. (2022). 'Statement: Conservation International Applauds Colombia's Announcement it has Protected and Conserved More Than 30% of Territory Ahead of Global Goals'. Available at: https://www.conservation.org/press-releases/2022/07/26/conservation-international-applauds-colombia-protected-and-conserved-30-of-territory-ahead-of-global-goals.

- Convery, F., Perthuis, C. and Ellerman, A. (2008) 'The European carbon market in action: the first trading period, Interim report'.

- Costanza, R. et al. (1997) 'The value of the world's ecosystem services and natural capital', *Ecological Economics*, 25(1), pp. 3–15. Available at: https://doi.org/10.1016/S0921-8009(98)00020-2.

- Costanza, R., Hart, M., Talberth, J., & Posner, S. (2009). 'Beyond GDP: The need for new measures of progress'. *Pardee Paper No. 4*, Boston: Pardee Center for the Study of the Longer-Range Future.

- Davalos, L. (2001) ‘Could Peace be Worse than War for Colombia’s Forests?’, *The Environmentalist*, 21, pp. 305–315. Available at: https://doi.org/10.1023/A:1012904318418.

- Dehm, J. (2016). ‘Carbon colonialism or climate justice? Interrogating the international climate regime from a TWAIL perspective’. *Special Issue: Conspiring in Cairo & Canada: Placing TWAIL Scholarship and Praxis*, 33:3, pp. 129-161. Available at: https://doi.org/10.22329/wyaj.v33i3.4893

- Dentzel, D. (2023). ‘The Future of Climate Finance: Analysis of the Regenerative Finance Community at the Intersection of Web3 and Climate’, *UC Santa Barbara*. Available at: https://escholarship.org/uc/item/00v7x929

- Descheneau, P. (2012) ‘The currencies of carbon: carbon money and its social meaning’, *Environmental Politics*, 21(4), pp. 604–620. Available at: https://doi.org/10.1080/09644016.2012.688356.

- Dikau, S. and Volz, U. (2021) ‘Central bank mandates, sustainability objectives and the promotion of green finance’, *Ecological Economics*, 184, p. 107022. Available at: https://doi.org/10.1016/j.ecolecon.2021.107022.

- Dion, D. (1998) ‘Evidence and Inference in the Comparative Case Study’, *Comparative Politics*, 30(2), pp. 127–145. Available at: https://doi.org/10.2307/422284.

- Du Plessis, C. and Brandon, P. (2015) ‘An ecological worldview as basis for a regenerative sustainability paradigm for the built environment’, *Special Issue: Toward a Regenerative Sustainability Paradigm for the Built Environment: from vision to reality*, 109, pp. 53–61. Available at: https://doi.org/10.1016/j.jclepro.2014.09.098.

- Dufrasne, G. (no date) *‘*Colombian fossil fuel companies abuse forestry offsets to avoid taxes*’, Carbon Market Watch*. Available at: https://carbonmarketwatch.org/2021/06/30/colombian-fossil-fuel-companies-abuse-forestry-offsets-to-avoid-taxes-report/ (Accessed: 09 August 2024).

- Dunne, D. and Quiroz, Y. (2023). Mapped: ‘The Impacts of Carbon-offset Projects Around The World’. *The Carbon Brief.* Available at: https://interactive.carbonbrief.org/carbon-offsets-2023/mapped.html.

- Dziwok, E. and Jäger, J. (2021) ‘A Classification of Different Approaches to Green Finance and Green Monetary Policy’, *Sustainability*, 13(21). Available at: https://doi.org/10.3390/su132111902.

- Eisenhardt, K.M. (1989) 'Building Theories from Case Study Research', *The Academy of Management Review*, 14(4), pp. 532–550. Available at: https://doi.org/10.2307/258557.

- Enabulele, O., Zahraa, M. and Ngwu, F. (2016) 'Addressing Climate Change due to Emission of Greenhouse Gases Associated with the Oil and Gas Industry, *Market-Based Regulation to the Rescue'*, 19, pp. 45–75. Available at: https://doi.org/10.1108/S2051-503020160000019003.

- Environmental Defense Fund (EDF). (2020). 'How Cap and Trade Works'. Available at: https://www.edf.org/climate/how-cap-and-trade-works#:~:text=Companies%20that%20cut%20their%20pollution [Accessed 11 Jun. 2024].

- Escarraga, L. (2024). 'La empresa colombiana que está redefiniendo la industria del oro con enfoque RE-DE-FI y explotación digital'. *Soy Hodler.* Available at: https://soyhodler.com/la-empresa-colombiana-que-esta-redefiniendo-la-industria-del-oro-con-enfoque-re-de-fi-y-explotacion-digital/.

- Escobedo, A. (2022). '*Colombia's Green Taxonomy: a First in Latin America*'. *Greenomy.io*. Available at: https://www.greenomy.io/blog/colombias-green-taxonomy.

- Evite, P.M. and Zara, R. (2023) 'Neocolonialism in Carbon Offset Markets', *SSRN Electronic Journal*. Available at: https://doi.org/10.2139/ssrn.4651498.

- Fairhead, J., Leach, M. & Scoones, I. (2012). 'Green Grabbing: a new appropriation of nature? ' *Journal of Peasant Studies*, 39:2, pp. 237-261. Available at: https://doi.org/10.1080/03066150.2012.671770

- Favasuli, S. and Sebastian, V. (2021). 'Voluntary carbon markets: how they work, how they're priced and who's involved'. *S&P Global*. Available at: https://www.spglobal.com/commodityinsights/en/market-insights/blogs/energy-transition/061021-voluntary-carbon-markets-pricing-participants-trading-corsia-credits.

- Fenwick, M. and Jurcys, P. (2022) 'The Contested Meaning of Web3 & Why it Matters for (IP) Lawyers'. Available at: http://dx.doi.org/10.2139/ssrn.4017790

- Finck, M. (2018) 'Blockchain Regulation and Governance in Europe'. Available at: https://doi.org/10.1017/9781108609708.

- Fleming, S. (2020). 'What is green finance and why is it important?', *World Economic Forum*. Available at: https://www.weforum.org/agenda/2020/11/what-is-green-finance/.

- Franke, L., Schletz, M., and Salomo, S. (2020). 'Designing a blockchain model for the Paris agreement's carbon market mechanism', *Sustainability* 12 (1068), 1068. Available at: https://doi:10. 3390/su12031068

- Fu, C., Lu, L. and Pirabi, M. (2023) 'Advancing green finance: a review of sustainable development', *Digital Economy and Sustainable Development*, 1(1), p. 20. Available at: https://doi.org/10.1007/s44265-023-00020-3.

- Fullerton, J. (2015). 'Regenerative Capitalism, *Capital Institute.* Available at: https://capitalinstitute.org/wp-content/uploads/2015/04/2015-Regenerative-Capitalism-4-20-15-final.pdf.

- Gari, S.R. *et al.* (2017) 'An Analysis of the Global Applicability of Ostrom's Design Principles to Diagnose the Functionality of Common-Pool Resource Institutions', *Sustainability*, 9(7). Available at: https://doi.org/10.3390/su9071287.

- Gibbons, L. (2020) 'Regenerative—The New Sustainable?', *Sustainability*, 12, p. 5483. Available at: https://doi.org/10.3390/su12135483.

- Gitcoin (2023). 'Barichara Regeneration Fund – Prototyping a Bioregional Regenerative Economy.' Gitcoin.co. Available at: https://checker.gitcoin.co/public/project/show/barichara-regeneration-fund-prototyping-a-bioregional-regenerative-economy.

- Gitcoin. (2024). 'Gitcoin: KOKO DAO saving forests in Colombia'. Available at: https://checker.gitcoin.co/public/project/show/koko-dao-saving-forests-in-colombia.

- González-Márquez, I. and Toledo, V.M. (2020) 'Sustainability Science: A Paradigm in Crisis?', *Sustainability*, 12(7). Available at: https://doi.org/10.3390/su12072802.

- Goodrick, D. (2014). *'*Comparative Case Studies, Methodological Briefs: Impact Evaluation 9*'*, *UNICEF Office of Research*, Florence.

- Goulder, L.H. and Schein, A.R. (2013) 'Carbon taxes versus cap and trade: a critical review', *Climate Change Economics*, 04(03), p. 1350010. Available at: https://doi.org/10.1142/S2010007813500103.

- Grasmann, S. (2022). 'Regenerative Finance (ReFi)'. *European Innovation Forum.* Available at: https://innovation-forum.org/regenerative-finance-refi/.

- Green Finance Platform (2020). 'Explore Green Finance'. *GFP*. Available at: https://www.greenfinanceplatform.org/page/explore-green-finance.

- Green Finance Platform (2022). ‘Green finance Platform’s Database Shows Significant Rise in Global Green finance Measures’*. GFP.* Available at: https://www.greenfinanceplatform.org/news/green-finance-platforms-database-shows-significant-rise-global-green-finance-measures.

- Greenfield, P. (2023). ‘Revealed: more than 90% of rainforest carbon offsets by biggest provider are worthless, analysis shows’, *The Guardian*. Available at: https://www.theguardian.com/environment/2023/jan/18/revealed-forest-carbon-offsets-biggest-provider-worthless-verra-aoe.

- Grubb, M; (2004) ‘Technology Innovation and Climate Change Policy: an overview of issues and options’. *Keio Economic Studies*, 41 (2) pp. 103-132.

- Guasca, M., Vanneste, D. and Van Broeck, A.M. (2022) ‘Peacebuilding and post-conflict tourism: addressing structural violence in Colombia’, *Journal of Sustainable Tourism*, 30(2–3), pp. 427–443. Available at: https://doi.org/10.1080/09669582.2020.1869242.

- Guskow Cardoso, A. (2023) ‘Decentralized Autonomous Organizations – DAOs: The Convergence of Technology, Law, Governance, and Behavioral Economics’, *SSRN Electronic Journal*. Available at: https://doi.org/10.2139/ssrn.4341884.

- Hardin, G. (1968) ‘The Tragedy of the Commons’, *Science*, 162(3859), pp. 1243–1248.

- Hartley, S., Rennie, E. (2022). ‘Regenerative Finance ‘‘ReFi’’: Blockchain for Climate Action’. *ARC Centre of Excellence for Automated Decision-Making and Society*. Available at: https://apo.org.au/node/321467

- Horlings, L. (2015) ‘The inner dimension of sustainability: personal and cultural values’, *Open Issue*, 14, pp. 163–169. Available at: https://doi.org/10.1016/j.cosust.2015.06.006.

- Howson, P. (2020) Climate Crises and Crypto-Colonialism: Conjuring Value on the Blockchain Frontiers of the Global South. *Front*. *Blockchain* 3:22. Available at: https://doi: 10.3389/fbloc.2020.00022

- Idelberger, F. and Mezei, P., 2022. Non-fungible tokens’. *Internet Policy Review*, 11(2). Available at: https://doi.org/10.14763/2022.2.1660

- IDMC (2021). ‘2021 Global Report on Internal Displacement’. *www.internal-displacement.org*. Available at: https://www.internal-displacement.org/global-report/grid2021/.

- Loannis, K. and Pantelidis, K. (2024) ‘DAO Dynamics: Treasury and Market Cap Interaction’, *Journal of Risk and Financial Management*, 17, p. 179. Available at: https://doi.org/10.3390/jrfm17050179.

- IUCN (2022). ‘Position Paper for UNFCCC COP27’, *United Nations Framework Convention on Climate Change.* Available at: https://iucn.org/sites/default/files/2022-11/iucn-position-paper-for-unfccc-cop27-final.pdf [Accessed 17 Apr. 2024].

- Jackson, T. 2009. ‘Prosperity without growth?’ Economics for a finite planet. *London : Earthscan/Sustainable Development Commission.* Available at: https://doi.org/10.1111/j.1530-9290.2009.00151.x

- Jain, Y. (2021) ‘Regenerative Economies: A New Approach Towards Sustainability’, pp. 1–11. Available at: https://doi.org/10.1007/978-3-319-69625-6_80-1.

- Jirásek, M. (2023) ‘Proof of Humanity DAO: No crypto-utopia… yet’, *SSRN Electronic Journal* [Preprint]. Available at: https://doi.org/10.2139/ssrn.4597772.

- Johansson, E. (2022). *Following a string of scandals: where will the crypto industry go in 2023*. [online] Verdict. Available at: https://www.verdict.co.uk/following-a-string-of-scandals-where-will-the-crypto-industry-go-in-2023/

- Jordan, R. (2023). ‘Colombia, a biodiversity hotspot, holds lessons for other countries trying to balance development with conservation’, *Stanford-led Study News.* Available at: https://news.stanford.edu/press-releases/2023/02/06/biodiversity-policy/.

- Kalnoki, A. (2022). ‘Explained: Proof-of-Work vs. Proof-of-Stake Carbon Footprint’. *www.bitwave.io*. Available at: https://www.bitwave.io/blog/explained-proof-of-work-vs-proof-of-stake-carbon-footprint.

- Keucheyan, R. (2014). ‘La Nature Est un Champ de Bataille: essai D'écologie Politique’. *La Découverte*, Paris.

- Koko DAO (2018). ‘Leveraging Web3 to reduce deforestation in Colombia’. Available at: https://kokodao.xyz/#about-us.

- Konietzko, J., Das, A. and Bocken, N. (2023) ‘Towards regenerative business models: A necessary shift?’, *Sustainable Production and Consumption*, 38. Available at: https://doi.org/10.1016/j.spc.2023.04.014.

- Kosoy, N. and Corbera, E. (2010) ‘Payments for ecosystem services as commodity fetishism’, *Special Section - Payments for Environmental Services:*

Reconciling Theory and Practice, 69(6), pp. 1228–1236. Available at: https://doi.org/10.1016/j.ecolecon.2009.11.002.

- Kreibich, N. and Hermwille, L. (2021). 'Caught in between: credibility and feasibility of the voluntary carbon market post-2020', *Climate Policy, 21(7), pp. 939–957.* Available at: https://doi.org/10.1080/14693062.2021.1948384.

- Krishnamoorthi, S. and Mathew, S.K. (2018) 'Business analytics and business value: A comparative case study', *Information & Management*, 55(5), pp. 643–666. Available at: https://doi.org/10.1016/j.im.2018.01.005.

- Kröger, M. (2014). 'The political economy of global tree plantation expansion: a review'. *The Journal of Peasant Studies*, 41:2, pp. 235-261, https://doi.org/10.1080/03066150.2014.890596

- Kumarathunga, M. et al. (2023) 'Blockchain Technologies and Environmental Sustainability', 36(9).

- Landholm, D et al. (2022). 'Unlocking nature-based solutions in Colombia: Technical Report', *Climate Focus.* Available at: https://climatefocus.com/wp-content/uploads/2022/09/Unlocking-Nature-based-Solutions-Colombia-Technical-Report-V1.1.pdf.

- Larsson, C. and Orvehed, M. (2021) 'Carbon Offsetting, a new form of CO2lonialism?: Local implications of tree-planting projects in East Africa', *Development Studies*. Available at: https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1564383&dswid=5485

- Lemus, N. (2014) 'Conflict-Induced Poverty: Evidence from Colombia', *Peace Economics, Peace Science and Public Policy*, 20(1), pp. 113–142. Available at: https://doi.org/10.1515/peps-2013-0056.

- Lindenberg, D.N. (2017) 'Definition of Green Finance', *German Development Institute*. Available at: https://www.cbd.int/financial/gcf/definition-greenfinance.pdf

- Linggih, N., Bryant, M. and French, A. (2023). 'The Future of Distributed MRV', *ReFi DAO*. Available at: https://blog.refidao.com/refi-roundup-52/

- Liu, C.L.C., Kuchma, O. & Krutovsky, K.V. (2018). 'Mixed-species versus monocultures in plantation forestry: Development, benefits, ecosystem services and perspectives for the future'. *Global Ecology and Conservation*, 15, pp. 1-13. Available at: https://doi.org/10.1016/j.gecco.2018.e00419

- Lohmann, L. (2005) ‘Marketing and making carbon dumps: Commodification, calculation and counterfactuals in climate change mitigation’, *Science as Culture*, 14(3), pp. 203–235. Available at: https://doi.org/10.1080/09505430500216783.

- Lohmann, L. (2010), ‘Uncertainty markets and carbon markets: variations on Polanyian themes’, *New Political Economy*, Vol. 15 No. 2, pp. 225-254. Available at: https://doi.org/10.1080/13563460903290946

- Maher, D. and Thomson, A. (2018) ‘A precarious peace? The threat of paramilitary violence to the peace process in Colombia’, *Third World Quarterly*, 39(11), pp. 2142–2172. Available at: https://doi.org/10.1080/01436597.2018.1508992.

- Mammadzada, K. *et al.* (2020) ‘Blockchain Oracles: A Framework for Blockchain-Based Applications’, in, pp. 19–34. Available at: https://doi.org/10.1007/978-3-030-58779-6_2.

- Marchant, G.E., Cooper, Z. and Gough-Stone, P.J. (2022) ‘Bringing Technological Transparency to Tenebrous Markets: The Case for Using Blockchain to Validate Carbon Credit Trading Markets’, *Natural Resources Journal*, 62. Available at: https://heinonline.org/HOL/Page?collection=journals&handle=hein.journals/narj62&id=178&men_tab=srchresults

- Marr, B. (2023). ‘From DeFi to ReFi: How The Future Internet Will Upend Your Financial World’. *Forbes*. Available at: https://www.forbes.com/sites/bernardmarr/2023/08/04/from-defi-to-refi-how-the-future-internet-will-upend-your-financial-world/

- Martineau, R. and Lafontaine, J.-P. (2019) ‘When carbon accounting systems make us forget nature: from commodification to reification’, *Sustainability Accounting, Management and Policy Journal*, 11(3), pp. 487–504. Available at: https://doi.org/10.1108/SAMPJ-07-2018-0178.

- Marx, K. (1867). ‘Capital: A critique of political economy’, *Volume 1, Part 1: The process of capitalist production.* New York, NY: Cosimo.

- Mason J. (2002) *Qualitative researching*, 2nd ed. London: Sage.

- Mastini, R. (2017). ‘Degrowth: the case for a new economic paradigm’. *Open Democracy*. Available at: https://www.opendemocracy.net/en/degrowth-case-for-constructing-new-economic-paradigm/.

- Maxwell, J.A. (2013) *Qualitative Research Design: An Interactive Approach: An Interactive Approach*. SAGE Publications (Applied Social Research Methods). Available at: https://books.google.co.uk/books?id=DFZc28cayiUC.

- McKinsey & Company (2023). 'What is Web3 technology (and why is it important)?'*, McKinsey*. Available at: https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-web3.

- Meyer, E., Welpe, I., Sandner, P. & Ponte, M., 2024. 'Regenerative finance: a crypto-based approach for a sustainable future', in: Cronqvist, H. & Pely, D.-J. (eds.) *The Elgar Companion to Decentralized Finance, Digital Assets, and Blockchain Technologies*. Chapter 16, pp. 313-326. Edward Elgar Publishing.

- Mignolo, W.D. (2019). 'Sustainable Development or Sustainable Economies? Ideas Towards Living in Harmony and Plenitude', *Socioscapes, International Journal of Societies, Politics and Cultures*.1:1, pp. 48-65. Available at: http://digital.casalini.it/10.48250/1004

- Miller, K. (2020). 'The Triple Bottom Line: What It Is & Why It's Important', *Harvard Business School Online.* Available at: https://online.hbs.edu/blog/post/what-is-the-triple-bottom-line.

- Moore, H., Davies, M., Mintchev, N. and Woodcraft, S. (eds). (2023). 'Prosperity in the Twenty-First Century: Concepts, models and metrics'. London: *UCL Press*. Available at: https://doi.org/ 10.14324/111. 9781800084452

- Morcillo, L.G. and Arocha, N. (2023). 'Colombia Leads the Way on ESG Reporting and Green Taxonomy'. *Latin Lawyer*. Available at: https://latinlawyer.com/guide/the-guide-environmental-social-and-corporate-governance/second-edition/article/colombia-leads-the-way-esg-reporting-and-green-taxonomy.

- Müller, E. (2020). 'Chapter 13: Regenerative development as natural solution for sustainability', *The Elgar Companion to Geography, Transdisciplinarity and Sustainability*. Cheltenham, UK: Edward Elgar Publishing. Available at: https://doi.org/10.4337/9781786430106.00021

- Munafò, M.R. *et al.* (2017) 'A manifesto for reproducible science', *Nature Human Behaviour*, 1(1), p. 0021. Available at: https://doi.org/10.1038/s41562-016-0021.

- Muñoz, P. and Branzei, O. (2021). 'Regenerative organizations: introduction to the special issue', *Organ, Environ*, 34 (4), 507–516. https://doi.org/10.1177/10860266211055740.

- Muradian, R. et al. (2013) ‘Payments for ecosystem services and the fatal attraction of win-win solutions’, *Conservation Letters*, 6(4), pp. 274–279. Available at: https://doi.org/10.1111/j.1755-263X.2012.00309.x.

- Naderifar, M., Goli, H. and Ghaljaei, F. (2017) ‘Snowball Sampling: A Purposeful Method of Sampling in Qualitative Research’, *Strides in Development of Medical Education*, In Press. Available at: https://doi.org/10.5812/sdme.67670.

- Newell, P. (2021) ‘Power Shift: The Global Political Economy of Energy Transitions’, *Cambridge University Press*. Available at: https://doi.org/10.1017/9781108966184.

- Newig, J. and Fritsch, O. (2009) ‘Environmental governance: Participatory, multi-level - And effective?’, *Environmental Policy and Governance*, 19, pp. 197–214. Available at: https://doi.org/10.1002/eet.509.

- OSTP. (2022). Climate and Energy Implications of Crypto-Assets in the United States. https://www.whitehouse.gov/wp-content/uploads/2022/09/09-2022-Crypto-Assets-and-Climate- Report.pdf

- Ostrom E. (1998). Self-governance of Common-pool Resources’, *U Newman P. (Editor) The New Palgrave Dictionary of Economics and the Law.* London: Macmillan Press.

- Ostrom, E. (1992) ‘Community and the Endogenous Solution of Commons Problems’, *Journal of Theoretical Politics*, 4(3), pp. 343–351. Available at: https://doi.org/10.1177/0951692892004003006.

- Oviedo, J.C. (2022). *‘*Integrating corruption considerations into Nationally Determined Contributions: Insights from Colombia’s climate adaptation efforts at the local level*’. U4 Issue*. Available at: https://open.cmi.no/cmi-xmlui/handle/11250/3034850

- Paterson, M. and Stripple, J. (2012), ‘Virtuous carbon’, *Environmental Politics,* Vol. 21 No. 4, pp. 563-582. Available at: https://doi.org/10.1080/09644016.2012.688354

- Paul, H.K. (2021) ‘Towards reparative climate justice: from crises to liberations’, *Common Wealth*. Available at: https://www.common-wealth.co.uk/reports/towards-reparative-climate-justice-from-crises-to-liberations.

- Pérez-Català, A. (2014). ‘Commodifying nature? Reflections around PES scheme’. Available at: https://climate-exchange.org/2014/02/17/commodifying-nature-reflections-around-pes-scheme/

- Persson, S., Buenadicha, C. and Gómez, C. (2023). 'Digital Tokens for Climate Action and Nature-Based Solutions: Exploration of Opportunities and Considerations', Inter-American Development Bank. Available at: doi:https://doi.org/10.18235/0004834.

- Plasencia, J. (2024). '*Carbon removal vs. carbon avoidance - Which tool to use when?*' *ClimateTrade*. Available at: https://climatetrade.com/carbon-removal-vs-carbon-avoidance-which-mechanism-to-use-when/

- Porras, I. and Chacon-Cascante, A. (2018) 'Costa Rica's Payments for Ecosystem Services programme', International Institute for Environment and Development (IIED). Available at: https://www.iied.org/g04272

- Poux, P., Filippi, P. and Ramos, S. (2020) *Blockchains for the Governance of Common Goods*, p. 12. Available at: https://doi.org/10.1145/3428662.3428793.

- Prem, M., Saavedra, S. and Vargas, J.F. (2020) 'End-of-conflict deforestation: Evidence from Colombia's peace agreement', *World Development*, 129, p. 104852. Available at: https://doi.org/10.1016/j.worlddev.2019.104852.

- Pring, C. and Vrushi, J., (2019). *'*Global Corruption Barometer Latin America & the Caribbean 2019: Citizens' Views and Experiences of Corruption*'*. Available at: https://digitalcommons.fiu.edu/cgi/viewcontent.cgi?article=1154&context=srhreports

- Ramirez, J., Velázquez, D. and Vélez-Zapata, C. (2022) 'The potential role of peace, justice, and strong institutions in Colombia's areas of limited statehood for energy diversification towards governance in energy democracy', *Energy Policy*, 168, p. 113135. Available at: https://doi.org/10.1016/j.enpol.2022.113135.

- ReFiDAO (2024). 'ReFi DAO Colombia'. ReFiDAO. Available at: https://www.refidao.com/community/local-/refi-colombia/r/recHj0qV0WmOvjn2y.

- Regen Network. (2024). 'Biocultural Jaguar Credits, Ancestral Stewardship in the Sharamentsa Community'. Available at: https://app.regen.network/project/sharamentsa-pilot [Accessed 31 Jul. 2024].

- Revelle, E. (2009) 'Cap-and-trade versus carbon tax two approaches to curbing greenhouse gas emissions', *Background Paper*. Available at: https://www.nber.org/system/files/working_papers/w19338/w19338.pdf

- Richards, C. Lyons, K. (2016). 'The new corporate enclosures: Plantation forestry, carbon markets and the limits of financialised solutions to the climate

crisis'. *Land Use Policy*, 56, pp. 209– 216. Available at: http://dx.doi.org/10.1016/j.landusepol.2016.05.013

- Ritchie, P. (2023). 'Peace with Nature: Rejuvenating war-torn Colombia with sustainable development'. *The University of Sydney*. Available at: https://www.sydney.edu.au/news-opinion/news/2023/10/26/rejuvenating-war-torn-colombia-with-sustainable-development.html.

- Robinson, O.C. (2014) 'Sampling in interview-based qualitative research: A theoretical and practical guide', *Qualitative research in psychology*, 11(1), pp. 25–41.

- Ross, S. (2024). 'What countries have the largest gold reserves? ', *Investopedia*. Available at: https://www.investopedia.com/ask/answers/040715/what-countries-have-largest-gold-reserves.asp.

- Santana, C. and Albareda, L. (2022) 'Blockchain and the emergence of Decentralized Autonomous Organizations (DAOs): An integrative model and research agenda', *Technological Forecasting and Social Change*, 182, p. 121806. Available at: https://doi.org/10.1016/j.techfore.2022.121806.

- Schletz, M. et al. (2023) 'Blockchain and regenerative finance: charting a path toward regeneration', *Frontiers in Blockchain, 6, p. 1165133.* Available at: https://doi.org/10.3389/fbloc.2023.1165133.

- Schneider, L. and La Hoz Theuer, S. (2018) 'Environmental integrity of international carbon market mechanisms under the Paris Agreement', *Climate Policy*, 19(3), pp. 386–400. Available at: doi: 10.1080/14693062.2018.1521332.

- Školník, M. (2020) 'The effects of corruption on various forms of political participation in Colombia', *Latin American Policy*, 11(1), pp. 88–102. Available at: https://doi.org/10.1111/lamp.12180

- Soundarrajan, P. and Vivek, N. (2016) 'Green finance for sustainable green economic growth in India', *Agricultural Economics (Zemědělská ekonomika)*, 62(1), pp. 35–44. Available at: https://doi.org/10.17221/174/2014-AGRICECON.

- SPAR6C. (2024). 'Colombia Overview'. Available at: https://www.spar6c.org/project-country/colombia.

- Spilker, G. and Nugent, N. (2022) 'Voluntary carbon market derivatives: Growth, innovation & usage', *Environmental, Social and Governance (ESG) and Sustainable Finance*, 22, pp. S109–S118. Available at: https://doi.org/10.1016/j.bir.2022.11.008.

- Stokel-Walker, C. (2022). 'What Is Regenerative Capitalism and Why Is It important?', *World Economic Forum*. Available at: https://www.weforum.org/agenda/2022/01/regenerative-capitalism-industry-explainer/.

- Strazzante, E., Rycken, S. and Winkler, V. (2021). 'Global North and Global South: How Climate Change Uncovers Global Inequalities'. *Generation Climate Europe*. *Generation Climate Europe*. Available at: https://gceurope.org/global-north-and-global-south-how-climate-change-uncovers-global-inequalities/.

- Taghizadeh-Hesary, F. and Yoshino, N. (2019). 'The way to induce private participation in green finance and investment', *Finance Research Letters, 31, pp.98–103.* doi:https://doi.org/10.1016/j.frl.2019.04.016.

- Tarazona, D. (2022). *'*El presupuesto del sector ambiente en Colombia es precario*'*, *Mongabay*. Available at: https://es.mongabay.com/2022/08/presupuesto-delsector-ambiente-en-colombia-es-precario-entrevista/

- Teixeira, F., Asher Schapiro, A., 2022. 'Fears of subprime carbon assets stall crypto mission to save rainforest', *Reuters*. Available at: https://www.reuters.com/article/idUSL8N2ZM7XE/.

- The Biodiversity Finance Initiative (BIOFIN) (2023). 'Colombia'. Available at: https://www.biofin.org/colombia.

- Toucan (2022). 'Public Consultation: Verra's Approach to Third-Party Crypto Instruments and Tokens', *Response document by Toucan Protocol.* Available at: https://blog.toucan.earth/content/files/2023/01/Toucan_Verra_response.pdf

- Toucan Protocol. (2023). 'What is ReFi', *Regenerative Finance explained*. Available at: https://blog.toucan.earth/what-is-refi-regenerative-finance/.

- Transparency Partnership. (2019). 'Tracking the financing of climate action: how Colombia developed and implemented a comprehensive national MRV framework for climate finance'. Available at: www.transparency-partnership.net/good-practice-database.

- Truth Commission of Colombia (2022). 'Truth Commission of Colombia: Executive Summary'. *ABColombia*. Available at: https://www.abcolombia.org.uk/truth-commission-of-colombia-executive-summary/.

- UNEP (2018). Green Financing. *UNEP - UN Environment Programme.* Available at: https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/green-financing.

- UNEP (2020). 'The Economics of Nature-based Solutions: Current Status and Future Priorities'*. United Nations Environment Programme.* Available at: https://www.un.org/sites/un2.un.org/files/2021/04/nature-based-solutions-20110426.pdf

- UNEP. (2021). 'Colombia - NDC Action Project'. *United Nation Environmental Programme.* Available at: https://www.unep.org/ndc/action-area/colombia.

- United Nations (2015). 'Paris Agreement'. Available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

- Valdivia, C. and Poblet, M. (2022) 'Governance of ReFi Ecosystem and the Integrity of Voluntary Carbon Markets as a Common Resource', *SSRN Electronic Journal*. Available at: https://doi.org/10.2139/ssrn.4286167

- Van Hecken, G., and Bastiaensen, J. (2010). 'Payments for ecosystem services: Justified or not? A political view'. Environmental Science & Policy, 13(8), 785-792. Available at: https://doi.org/10.1016/j.envsci.2010.09.006

- Velasco-Herrejón, P., Bauwens, T. and Calisto Friant, M. (2022) 'Challenging dominant sustainability worldviews on the energy transition: Lessons from Indigenous communities in Mexico and a plea for pluriversal technologies', *World Development*, 150, p. 105725. Available at: https://doi.org/10.1016/j.worlddev.2021.105725.

- Voshmgir, S. (2019) *Token Economy: How Blockchains and Smart Contracts Revolutionize the Economy*. BlockchainHub. Available at: https://books.google.co.uk/books?id=-Wp3xwEACAAJ.

- Wæraas, A. (2022) 'Thematic Analysis: Making Values Emerge from Texts', in G. Espedal et al. (eds) *Researching Values: Methodological Approaches for Understanding Values Work in Organisations and Leadership*. Cham: Springer International Publishing, pp. 153–170. Available at: https://doi.org/10.1007/978-3-030-90769-3_9.

- Watson, A. (2022). 'Building regenerative carbon markets with web3: Toucan Protocol, *Toucan.* Available at: https://blog.toucan.earth/building- regenerative-carbon- markets- with- web3/.

- Wendl, M., Doan, M.H. and Sassen, R. (2023) 'The environmental impact of cryptocurrencies using proof of work and proof of stake consensus algorithms: A

systematic review', *Journal of Environmental Management*, 326, p. 116530. Available at: https://doi.org/10.1016/j.jenvman.2022.116530.

- Wijnand Stoefs (2021) *'*Companies use "Hot air" forestry offsets to avoid taxes in Colombia*',* *Carbon Market Watch*. Available at: https://carbonmarketwatch.org/publications/companies-use-hot-air-forestry-offsets-to-avoid-taxes-in-colombia/.

- World Bank (2022). 'Colombia: The First Sovereign Bond in Local Currency in Latin America Case Study'. *World Bank*. Available at: https://thedocs.worldbank.org/en/doc/bc687cc79a64b1640b0a1e7af7a56142-0340012022/original/WB-Colombia-Greenbond-CaseStudy-Final.pdf.

- World Rainforest Movement (2003). 'Brazil: Plantar's eucalyptus plantations, carbon credits and local people'*. World Rainforest Movement*. Available at: https://www.wrm.org.uy/bulletin-articles/brazil-plantars-eucalyptus-plantations-carbon-credits-and-local-people [Accessed 6 Jun. 2024].

- World Wildlife Fund. (2017). 'A Look at the Natural World of Colombia'. [online] Available at: https://www.worldwildlife.org/magazine/issues/winter-2017/articles/a-look-at-the-natural-world-of-colombia#:~:text=Colombia%20is%20the%20second%20most.

- Wright, A. and De Filippi, P. (2015) 'Decentralized Blockchain Technology and the Rise of Lex Cryptographia', *SSRN Electronic Journal*. Available at: https://doi.org/10.2139/ssrn.2580664.

- Wunder, S. (2005). 'Payments for environmental services some nuts and bolts', *Center for International Forestry Research (CIFOR)*. Available at: http://www.jstor.org/stable/resrep01829.

- Yin, Robert K., 1998, 'The Abridged Version of Case Study Research', in L. Bickman, L. and D.J. Rog, (eds.), Handbook of Applied Social Research Methods, *Thousand Oaks: Sage Publications*, pp. 229–259

- Zhao, X. *et al.* (2022) 'Task management in decentralized autonomous organization', *Journal of Operations Management*, 68. Available at: https://doi.org/10.1002/joom.1179.

9. Appendixes

Appendix A. ESG Criteria

Environmental	Social	Governance
• Climate change and emissions reduction • Water use • Biodiversity • Energy efficiency • Waste management • Circularity	• Customer satisfaction • Diversity • Employee welfare and wellbeing • Health and safety Contribution to the community • Training • Human rights	• Corporate governance system • Transparency and integrity • Remuneration • Cybersecurity • Responsible supply chain

Appendix B. UN SDGs

Appendix C. Semi-Structured Interview Questionnaire

For ReFi founders:

1. What are the main goals and objectives of your ReFi initiative?

2. Can you describe how you identified the need to fund your ReFi initiative? Was it a sudden realisation or something that evolved?

3. How did you connect this need with the communities involved?

4. What were the initial challenges you encountered when implementing your ReFi initiative?

5. What strategies have you used to overcome these challenges and implement your operating model?

6. How do Web3 and other cutting-edge technologies contribute to the operation of your ReFi initiative?

5. How do you ensure that community members have meaningful participation and representation in decision-making processes for ReFi projects?

6. Which partnerships or collaborations have been crucial to the success of your ReFi initiative in Colombia?

7. Beyond financial metrics, how do you assess ReFi's impact on the socio-economic dynamics of rural communities in Colombia?

8. What role do local cultural practices and traditions play in implementing ReFi initiatives in Colombia?

9. How do you define prosperity within the context of ReFi initiatives, and what specific indicators do you use to measure it?

10. How do you view the progress of the ReFi movement in Colombia? How does its advancement compare to that in other countries?

11. What is your long-term vision for ReFi in Colombia, and what steps are you taking to achieve it?

For non-ReFi environmental specialists:

1. Can you describe your field of work in climate resilience and how your organisation contributes to regenerative practices?
2. What is your understanding of the ReFi framework, and do you see it as an effective approach?

3. Have you considered implementing ReFi approaches within your organisation? If so, what potential do you see?

4. How do you perceive the progress of the regenerative movement in Colombia, and specifically, what is your view on the advancement of ReFi in the country?

5. What are the main challenges of implementing environmental practices and Nature-based Solutions (NbS) in Colombia?

6. What role do local governments and other institutions play in either promoting or hindering the emergence of regenerative practices?

7. What are your thoughts on using Web3 and other advanced technologies in climate resilience strategies? How do you view use cases such as nature tokenisation?

8. What metrics would effectively measure the impact of ReFi and other regenerative practices on local communities?

9. From your perspective, what does prosperity mean for local communities, and how do you envision achieving it through ReFi initiatives?

10. How do you envision the long-term impact of ReFi and other regenerative practices on local communities?

Appendix D. Themes and Subthemes