

Master's Thesis

Strategic Niche Management for Levering the Blockchain Technology towards Scaling up the Financing of Nature-based Solutions through Voluntary Carbon Markets: A Case Study.

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Abstract

This study investigates the potential of leveraging Blockchain Technology and Voluntary Carbon Markets (VCM) to increase funding for rural nature-based solutions (NBS). Using Geels' Framework of Strategic Niche Management, the research examines the socio-technological innovation niche centred around blockchain applications in the context of NBS funding. The study addresses the research question of how blockchain technology can contribute to closing the funding gap for NBS through VCM. Data is gathered through qualitative interviews with experts and stakeholders active in the niche.

The findings reveal that blockchain technology can address certain barriers hindering increased funding for NBS. Additionally, the study explores the niche's management and experiment processes, which appear to be well-structured and purposefully designed. Furthermore, the research investigates processes around scaling up the niche to effectively close the funding gap. It highlights the nascent stage of the niche, indicating that upscaling patterns are yet to be established. However, the study finds that the impact and implications of such technological systems must be understood better before scaling can be pursued.

The academic significance of this research lies in its exploration of a disruptive technology that remains largely unexplored within the specific use case of NBS funding. The study contributes to the understanding of the potential role of blockchain in addressing the funding challenges faced by NBS initiatives. Societally, the research underscores the importance of closing the funding gap for nature-based solutions, as these interventions play a critical role in combating climate change and biodiversity loss. By shedding light on the promising applications of blockchain technology and VCM in funding NBS, this study offers valuable insights for policymakers, practitioners, and researchers striving to achieve sustainable and impactful solutions for environmental challenges.

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- dMRV** Digital measurement, reporting and verification
- MLP** Multi-level Perspective
- NBS** Nature-based Solutions
- NFT** Non-fungible Token
- SNM** Strategic Niche Management
- VCM** Voluntary Carbon Markets
- ReFi** Regenerative Finance
- Web3** All kinds of blockchain-based technologies

1 Introduction

Climate change is a phenomenon that has become an increasing concern for humanity as its impacts continue to threaten our planet's environmental and economic stability (IPCC, 2022). As such, identifying and implementing sustainable solutions has become a crucial topic for researchers and policymakers alike. A central approach to mitigate and adapt to climate change are nature-based solutions (NBS) through capturing carbon, which involve subsistence farming and extensive land-use as well as the restoration and management of natural ecosystems such as forests, wetlands, and oceans (IPCC, 2022; Johnson, Kumar, Okano, Dasgupta, & Shivakoti, 2022).

However, financing NBS projects is often challenging, as they tend to lack traditional revenue streams (Toxopeus & Polzin, 2017; UNEP, 2021). The annual investments into NBS need to be at least quadrupled until 2050 to \$ 536 bn per year if climate change shall stop at 2 degrees (UNEP, 2021). Voluntary Carbon Markets (VCM) have emerged as a promising solution for funding NBS projects, where individuals and organizations can purchase carbon credits to offset their carbon emissions (Miltenberger, Jospe, & Pittman, 2021). This incentivizes the development of projects that reduce greenhouse gas emissions and promotes the protection and restoration of natural ecosystems (UNEP, 2021).

The funding gap for NBS projects has social implications. Well implemented NBS are creating ecosystem services, supporting livelihoods and reduce poverty (IUCN, 2020). A lack of funding hinders societies to thrive, especially in developing countries. Closing the funding gap is crucial for vulnerable communities. Beyond that, NBS are critical for mitigating climate change impacts with far-reaching impacts on human societies, including health, economy, and social stability, and a key to create a resilient society (IUCN, 2020).

The emergence of Blockchain Technology has opened new possibilities for financing NBS-related carbon credits through transparent and secure digital transactions. This technology offers new mechanisms for tracking and verifying carbon credits, which can ultimately increase the value and accessibility of these credits for both buyers and sellers. Beyond that, it can make the VCM accessible to new groups of project developers (Howson, 2021; Howson, Oakes, Baynham-Herd, & Swords, 2019; Rozas, Tenorio-Fornés, Díaz-Molina, & Hassan, 2021).

Despite the growing interest in the potential of Blockchain Technology in increasing the funding stream of NBS projects through VCMs, there remains a notable research gap on how the technological niche of using Blockchain technology for financing NBS projects through carbon credits can be effectively scaled up. While there have been studies on the feasibility and benefits of using Blockchain Technology for carbon credit markets and NBS projects, none have focused on the challenges of scaling up these initiatives. Therefore, further research is needed to investigate the opportunities and obstacles for scaling up the technological niche around VCM, NBS, and Blockchain Technology, and to develop strategies to support the wider adoption of these novel solutions.

This leads to the following research questions:

RQ: How can blockchain technology contribute to closing the funding gap for Nature-based Solutions via voluntary carbon markets?

SRQ1: In which state are the experiment processes within the niche of using blockchain technology for financing Nature-based Solutions through using VCM?

SRQ2: Which upscaling patterns are in place and which processes need to be strengthened to effectively scale up this niche and contribute to close the funding gap?

These research questions were guided by the Multi-level Perspective (MLP) developed by Geels (2002) and analysed through the lens of Strategic Niche Management (SNM), following Naber, Raven, Kouw, and Dassen (2017). This study then investigated the strategies used to manage the niche of using blockchain technology for financing NBS through Voluntary Carbon Markets, and how this niche can be effectively scaled up to address the funding gap (for the theoretical background, see chapter 3).

Data was gathered through qualitative interviews. Through qualitative interviews with experts and stakeholders, the research aimed to identify the analytical and descriptive processes that can be employed to understand the processes within this niche, and how these processes can lead to potential shifts in the socio-technical regime (for the methodology, see chapter 4).

This study's results are presented in chapter 5 and discussed in chapter 6. Concluding, the findings of the study are contributing to the growing literature on sustainable solutions for climate change. Beyond that, the findings can serve to inform policy and decision-making regarding the use of blockchain technology for financing NBS projects, as well as companies operating within the innovation niche to ally towards scaling up.

2 The State of Voluntary Carbon Markets, Nature-based Solutions and Blockchain Technology

This chapter gives an overview on central concepts and relevant background knowledge in this thesis. These are voluntary carbon markets (VCM), Nature-based solutions (NBS), the funding gap for NBS, the Blockchain technology, and the links between these areas.

2.1 Voluntary Carbon Markets

To compensate for climate damaging emissions, there are mandatory carbon markets and voluntary carbon markets (VCM). VCM are free markets, and they are mainly steered by demand and supply. On the demand side, there are different actors. Institutions or companies, that want to become climate neutral can do so through buying certificates for carbon reduction projects to balance out their own emissions. The demand for such certificates rose in the past and is prognosed to grow further. Therefore, some investors buy carbon certificates as investment products, with the expectation to sell the certificates with a profit in the future (Bayon, Hamilton, & Hawn, 2009; Miltenberger et al., 2021).

The quality of the carbon credits varies, and the actual impact of different credits often is unclear or untransparent (Miltenberger et al., 2021). There are different standards to which projects that generate carbon credits can adhere to, such as the Verified Carbon Standard by Verra (Verra, 2023), or the Gold Standard by the same-called organization (The Gold Standard, 2022). Adhering to a standard includes being audited, and often, the company certifying the credits registers the project with their issued carbon credits in their registry. There are many active registries, e.g. the International Carbon Registry from the same-named organisation, the registry from Verra, the Climate Warehouse registry from World Bank (Climate Warehouse, 2023; International Carbon Registry, 2022; Verra, 2022).

If a carbon credit is bought to compensate for carbon emissions, then it is retired. However, a central challenge to the current VCM is that carbon credits often are used more than once. This so-called double counting is problematic, because it zeroes out the intended impact and makes the market untrustworthy (Kreibich & Hermwille, 2021, p. 9).

To finance projects issuing carbon credits, the project developers, the institutions that set up a project that captures carbon and then follows through with the process of creating carbon credits according to the project, may need investments to bridge the gap in time from starting the project to getting revenue through selling the carbon credits (Bayon et al., 2009).

The connections and the interactions between main players in the voluntary carbon market is shown in Figure 1.

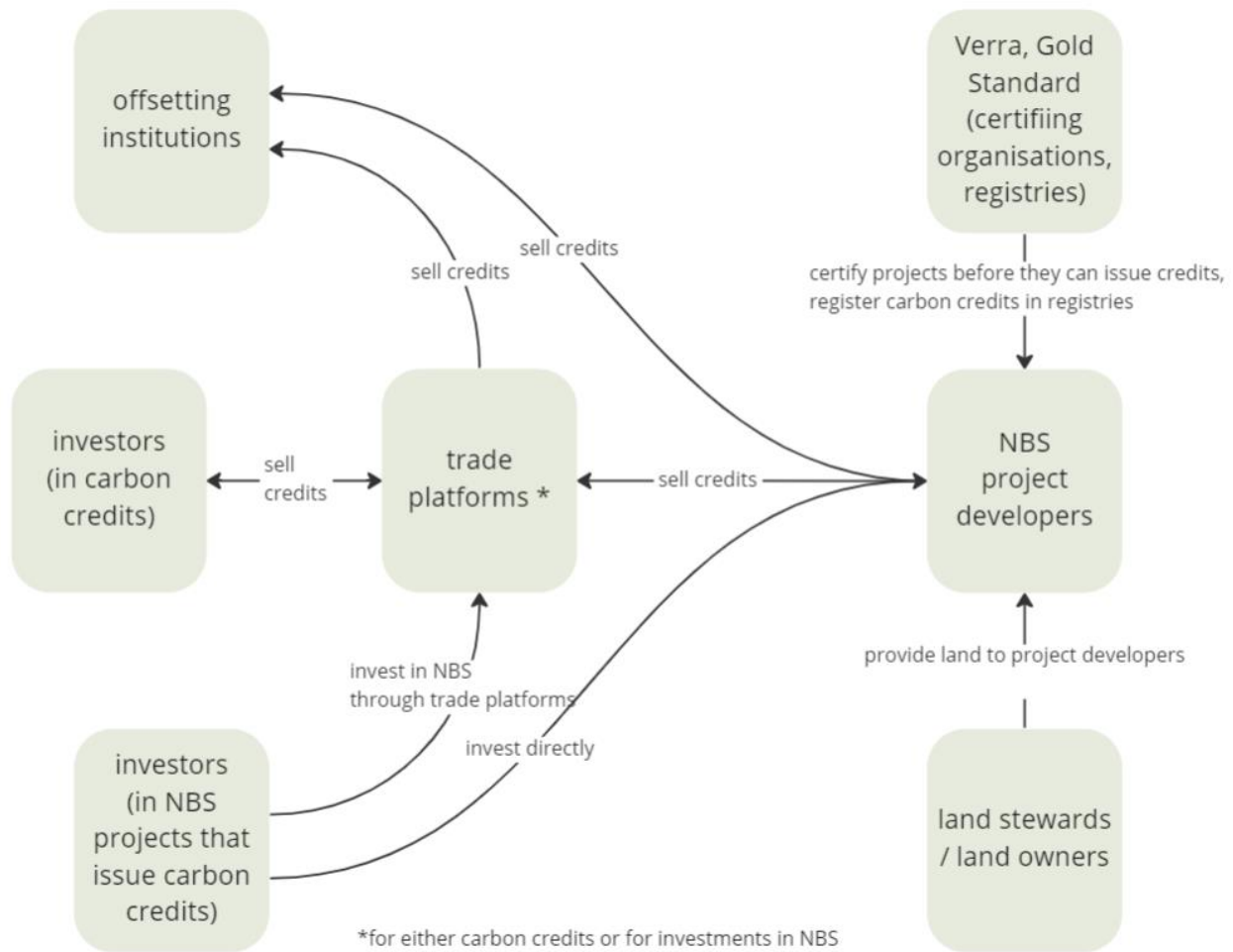


Figure 1: Stakeholders and their connections in voluntary carbon markets, own depiction. After Bayon et al. (2009).

There are several risks seen in VCM. Lamb et al. (2020) classify voluntary markets as non-transformative because the carbon credit buyers do not have strong incentives to change their behaviour. Another risk is seen in relying on market logics instead of setting up the governance structures to tackle a problem (Atzori, 2015). However Miltenberger et al. (2021) see opportunities in VCM, through them building a bridge from no markets to mandatory markets, and assume that VCM will be replaced by mandatory markets by 2050.

Within the VCM, there is a variety in origins where the carbon credits can come from (Bayon et al., 2009). In this research, the focus lies on carbon credits issued by projects around rural NBS, which will be explained in section 2.2.

2.2 Nature-based Solutions

Nature-based Solutions (NBS) are highlighted in the last IPCC report IPCC AR 6 for climate change mitigation and adaptation due to their key role in dealing with climate change, and additionally with biodiversity loss (IPCC, 2022). Definitions of NBS slightly vary, the overarching concept is that NBS are approaches for climate change adaptation, that are nature-, not technology-based. NBS capture

the benefits that ecosystems provide to increase the wellbeing of humans through both having recreational areas and through protection from increased climate-related risks, capture and store carbon, while building habitats that lead to a net gain to the integrity of the ecosystem and its biodiversity. Implementing NBS entails to manage ecosystems sustainably, to protect or restore them (IUCN, 2020; Johnson et al., 2022).

There are urban and rural NBS, and this research focusses at rural NBS, due to their larger scale. The scale is important when it comes to issuing carbon credits. While urban NBS often are of a smaller scale and tackle other areas than large scale carbon removal through biomass, they normally do not partake in the VCM (Mayor et al., 2021). In contrary to this, rural NBS often go hand in hand with storing carbon and potentially with issuing carbon credits (IPCC, 2022). Rural examples of NBS are for example switching to regenerative agriculture; conservation and restoration of ecosystems, and rural NBS can be land- or water based, such as reforestation of mangroves, regenerating coral reefs or kelp forests (Johnson et al., 2022).

Stakeholders at rural NBS are the people living within the area, which sometimes are at the same time the land stewards and living in harmony with the ecosystem since generations and contributing to the ecosystem as it is, and the project developers which often are initiatives rooted in the global north, with the aim to restore or protect the local ecosystem and investors that fund the project developers (Lang, 2018; UNEP, 2021).

2.2.1 The Funding Gap for Nature-based Solutions

In previous research on the funding gap for NBS, Mayor et al. (2021) focussed on financing, governance and business models for urban NBS to mainstream them, and Hagedoorn, Koetse, van , and Brander (2021, p. 2) researched into time contributions to reduce the finance need for urban NBS.

The UNEP (2021) states that the annual investments into NBS need to be at least quadrupled until 2050 to a flow of \$ 536 bn per year for land-based NBS, if climate change shall stop at 2 degrees, land degradation shall stop, and the intactness of global biodiversity shall be stabilised at today's levels. The current annual funding flow is \$134 billion per year, from which \$18 billion come from private sector finance. For the year 2019, a report from the Association for Financial Markets in Europe (AFME, 2022) finds a similar funding gap (estimated at \$598 to \$824 bn annually) and similar annual investments (estimated at \$125 to \$143 bn). Furthermore, they estimate the current funding NBS projects related to carbon markets at \$1 bn. They state that more than half of the funding gap could be closed with discontinuing harmful subsidies (AFME, 2022, p. 10).

Barriers in funding NBS are rooted in market failures, such as the lack of remuneration for public goods and services and over-exploitation of common access resources. Beyond that, subsidies for harmful environmental activities creates an unequal playing field for returns on investing in NBS. A coherent system to measure and, based on the measurements, monetise the impact of NBS is not in place (AFME, 2022, p. 9; UNEP, 2021).

To scale up the implementation of NBS, scaling up private finance into NBS projects is seen as one of the central challenges (UNEP, 2021). For this, the public sector's role is seen as creating a favourable environment for investments in NBS, through reducing the named above barriers. Beyond that, barriers are often small ticket sizes, a lack of suitable funding mechanisms, which

are linked to a lack of revenue from investing in NBS, which is rooted in the barriers (UNEP, 2021). An opportunity for the private sector is seen in aggregating different small-scale projects to de-risk them to an extent that they are attractive to mainstream investors. Furthermore, the transaction costs of small scale NBS projects are high, which would need to be changed to attract private investors. Around that, there is an opportunity to develop new financial products (UNEP, 2021).

2.3 Blockchain Technology for Nature-based Solutions and Voluntary Carbon Markets

At the intersection of NBS, VCM and Blockchain technology, stakeholders are the ones related to VCM and NBS, and start-ups and initiatives that develop the technology with the aim to change the dominant regime of VCM and NBS. There are multiple opportunities seen in using Blockchain technology to scale up investments in NBS and VCM.

The first practical blockchain-based product was launched in 2008 with a cryptocurrency, and the technology is still in its early stage. In the past years, there have been rapid developments of the technology and the technology started to be applied in a variety of sectors and use cases. The core concept of blockchains is that it is so to say a distributed database, where different users host the database together, and to alter entities of the database, consensus of the users is needed. The stored data, or parts of it often are publicly available. Furthermore, it can be immutable, so no single host can change its history. Due to this and its decentralisation, there is no single point of authority that could alter the system or collapse it (Howson et al., 2019; Howson, 2021; Rozas et al., 2021).

Table 1: Overview over frequently mentioned core functionalities of Blockchain in relation to VCM. Own depiction.

Concept	Potential functionality
Tokenisation	<ul style="list-style-type: none"> No double counting, increased transparency, increased trust Dynamic NFTs – quality control
Marketplaces	<ul style="list-style-type: none"> Liquid marketplaces & public price discovery, efficiency of markets Streamlining & transparent investment process -> better financing for project developers, more willingness of investors to invest
Fractionalisation and pooling	<ul style="list-style-type: none"> New demand sources through tokenisation (easier access) New supply sources through tokenisation (easier access)
Smart Contracts	<ul style="list-style-type: none"> Royalties to e.g. project developers or land stewards with trades Surveillance of projects linked to the tokens

Tokenisation of assets is the process of creating a digital proof of ownership for an asset, which can streamline actions around owning, buying or selling these assets. Tokenisation, and having digital registries can solve problems such as **double spending**, as the metadata (e.g. project of origin, quality, retired / active) from the single carbon credits is comparable at scale if digital, and

as retired tokens cannot be traded or retired again when digital (Climate Warehouse, 2023; Rozas et al., 2021; Toucan Protocol, 2022).

Non-fungible Tokens (NFTs) represent something else than a currency and could for example represent a piece of a forest. Dynamic NFTs are NFTs, where a subset of parameters can be updated based on real-world input. In the case of a dynamic NFT representing a piece of forest, the dynamic part could be determined by the forest's health or maturity on that piece of land. Dynamic NFTs could play a role in **verifying the progress** and the impact of carbon credit projects (Chainlink, 2022; Dowling, 2022, p. 1; Howson et al., 2019; Oberhauser, 2019; Toucan Protocol, 2022).

Furthermore, **marketplaces** for tokens can add transparency to the projects, transparency of price discovery and cut out the potentially price-determining middlemen. Through tokenisation, a market for natural assets will emerge, which will increase the attractiveness for both investors and project developers (Howson et al., 2019; Subramanian, 2017; Sullivan, 2018; Toucan Protocol, 2022).

Through tokenisation, it can be easier to **pool or fractionalise** NBS projects so that they can get better access to funding and to make the investments tradable which increases flow of funding, opens new sources of funding, new demand and new supply sources (Kim & Huh, 2020; Sullivan, 2018; Toucan Protocol, 2022; Toxopeus & Polzin, 2017).

There are functionalities that go beyond a pure financial currency and are based on the same technology. **Smart Contracts** are contracts programmed into the token. With implementing royalties through smart contracts, the project issuers or the land stewards could structurally benefit from trade through getting a share of the traded price every time the token is traded. This could counteract on that the trade of already issued carbon credits only benefits the traders and not the token issuers (Howell, 2023). Through smart contracts that are triggered by external inputs (e.g. satellite data), the quality of a NBS project can be monitored and the metadata of the token updated (Oberhauser, 2019; Toucan Protocol, 2022).

3 Theoretical framework: Transitions

Numerous theories around systems change, transitioning a system into a new state and scaling new concepts are evolving around Multi-level Perspective (MLP) (Lam et al., 2020). MLP, a concept coined by Geels (2002) is based on the work of Kemp (1994), on the underlying dynamics of radical shifts and innovations in the market towards more environmentally friendly technology. MLP builds on these dynamics and frames the interplay into different levels: niche, regime and landscape (see Figure 2). The dominant socio-technical regime is regulated by the landscape, and potentially changed by radical innovations emerging & scaling up out of niches. The regime is defined by more incremental innovations and by predictable technological trajectories. Technology developers of market-leading companies, policy makers, capital providers, common practices in the sector and the market and research play a role in the regime. The regime is influenced by the Landscape and different Niches. The landscape is slow in change and defined by external factors such as economic growth, energy prices, political situations or societal values. In contrast to the steadiness of the regime and the landscape, niches are in MLP seen as places where experimentation and following radical innovations can happen. This happens on a small scale, because the niches are disconnected to a certain extent and thus protected from the regime. A crucial aspect of niches is that experimentation does not only happen on a product level, but a niche is an environment where social networks can emerge, which foster the experimentation and radical innovation (Geels, 2002).

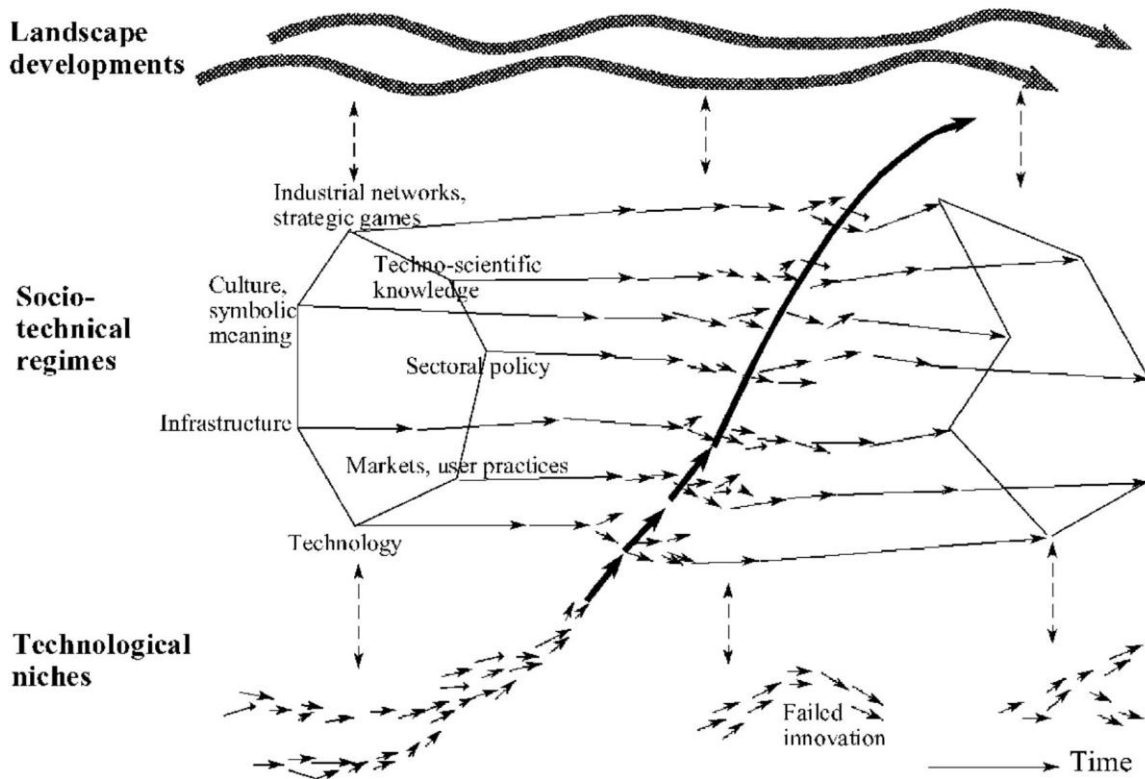


Figure 2: A dynamic multi-level perspective on technological transitions (Geels, 2002, p. 1263)

Classifying the VCM through the lens of MLP, the traditional VCM is the socio-technical regime, and the landscape development is awareness and urgency to act around climate change. The niche observed in this study evolves around altering the VCM through blockchain technology.

Looking at the VCM, initiatives using the Blockchain technology are only recently emerging, are not the market standard, challenge the dominant players in the regime and often do not have the power to precede (Chow, 2022). Players in the regime are interested in and cautious towards the technology (IFC, 2022). With different potential sources for Carbon Credits, NBS are underfunded and thus not developed and dominant yet (IUCN, 2020). Thus, the subsection of using the Blockchain Technology around carbon-credit creating NBS is a technological niche.

3.1 Strategic Niche Management for Blockchain Technology around VCM and NBS

The focus of this research is to observe the state of the niche around Blockchain technology, VCM and NBS through the patterns of upscaling and the processes within the niche, as well as at which next steps should be taken by the niche to scale up further.

The different potential efforts to increase the impact of radical innovations are conceptualised in amplification frameworks (Lam et al., 2020). The amplification framework Strategic Niche Management (SNM) is used to analyse and describe the processes happening within a niche, which are potentially working towards socio-technical shifts in the regime (Geels, 2002; Lam et al., 2020). Furthermore, with SNM experiments can be designed with the purpose to diffuse and scale up innovations and to eventually transition the regime towards a new state (Naber et al., 2017).

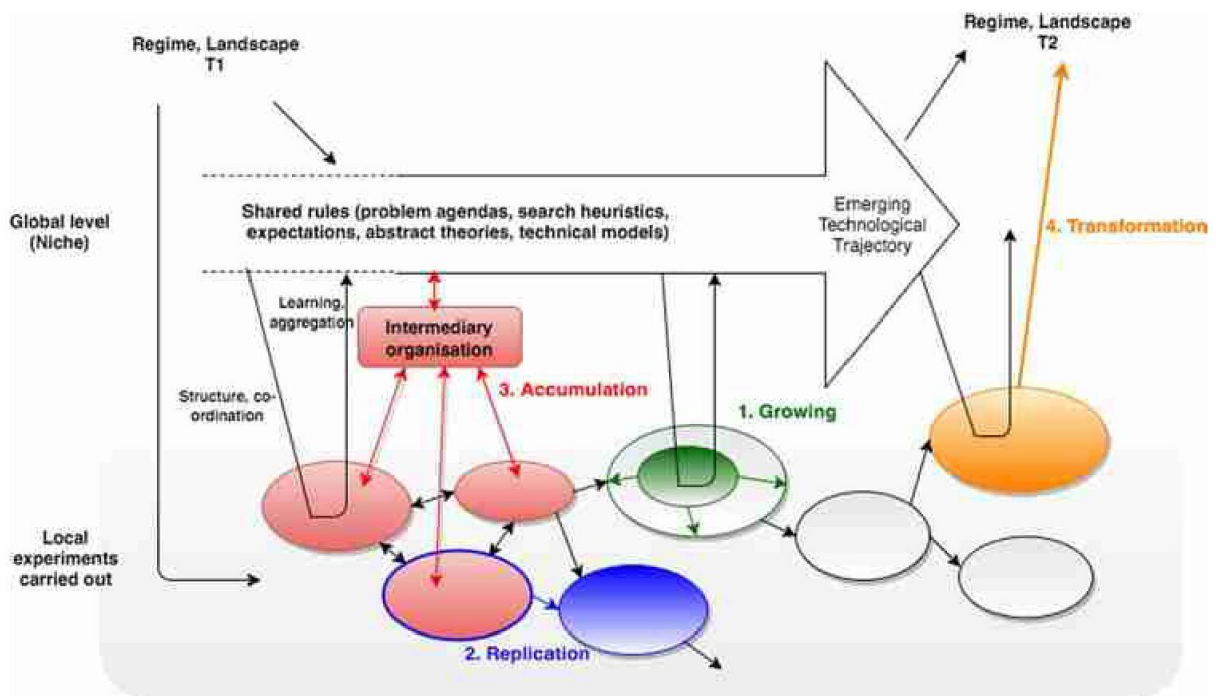


Figure 3: Patterns of upscaling and the emerging technological trajectory within a Niche (Naber et al., 2017, p. 344)

For this thesis, SNM is chosen, because it goes beyond the assumption that the development of a new technology will push itself on the market and rather analyses the socio-technical dynamics (Naber et al., 2017). The technology can impact social systems to a fair extent, and thus not only the technological, but also the social systems change are relevant to analyse (Howson et al., 2019; Howson, 2021; Oberhauser, 2019; Rozas et al., 2021).

SNM has the purpose to design and describe experiments. SNM classifies **three interdependent processes** within a niche, which are social network building, articulation of visions and expectations, and learning processes. The designed experiments are meant to contribute positively to these three processes. **Social networks** contribute to a system’s change when the network is broad (with different types of actors) and deep (with actors committed to mobilise resources). **Expectation articulation** is especially important for technology that is not market ready yet and serves to gather people and resources behind a shared vision. **Learning processes** can be broad (what includes alignment in technical and social approaches) and reflexive, if there is a willingness to pivot (not only concerning the technology but also concerning hypotheses, and how concepts are framed and referenced to). These processes alone are not enough to create social and technical systems change; to achieve such a change, at one point there needs to be interaction between niche and regime, and for the change to be nudged by the niche, regime and landscape need to be in a certain state (Naber et al., 2017).

Table 2: Classification of the experiment processes and their subcategories. Adapted from (Naber et al., 2017, p. 351).

Experiment process	Subcategories	Explanation
Social Network Building	Broad	The network consists of actors from different domains
	deep	Resource commitment of the members is high
Articulation of visions and expectations	Articulation	Expectations are clearly articulated between the members
	Robustness	Expectations are shared by the members
	Quality	Expectations are substantiated by on-going experiments, research, and experts
Learning Processes	Broad	Learning took place on several dimensions
	Reflective	Assumptions about the underlying problem definition, function or desirability of the socio-technological change are questioned

In these experiment processes, there are **four patterns** described that influence the experiments’ ability to scale up and diffuse: growing, replication, accumulation, and transformation. **Growing** refers to the continuing of an experiment with more actors participating in it or with an increasing market. **Replication** refers to the main concept being replicated, **accumulation** is the process of increased connectivity of the experiment to other initiatives, and in this pattern, intermediary organisations can play a connecting role. If accumulation proceeds, the global niche gets on a more stable trajectory concerning its development. **Transformation** refers to the niche causing institutional changes in the regime (Naber et al., 2017).

Table 3: SNM's four patterns of upscaling and diffusion. Source: (Naber et al., 2017, p. 346).

Pattern of upscaling	Explanation
Growing	The experiment continues and more actors participate, or the scale at which technologies are used increases
Replication	The main concept of the experiment is replicated in other locations or contexts
Accumulation	Experiments are linked to other initiatives
Transformation	The experiment shapes wider institutional change in the regime selection environment

4 Methods

To answer the research question, the different stakeholders that are active in the niche were identified. The actors were interviewed with the purpose to understand their view and experience with the interview questions guided by the three experiment processes of SNM (table 2) and the four upscaling patterns (table 3).

For this, a case study approach was chosen. A case study approach involves in-depth and detailed investigation of a specific individual, group, organization, or event to provide an in-depth analysis of a complex phenomenon within its real-life context (Bryman, 2016). As the analysed niche is one of many applications of the Blockchain technology, and a niche in VCM and NBS, the niche is viewed as a single case.

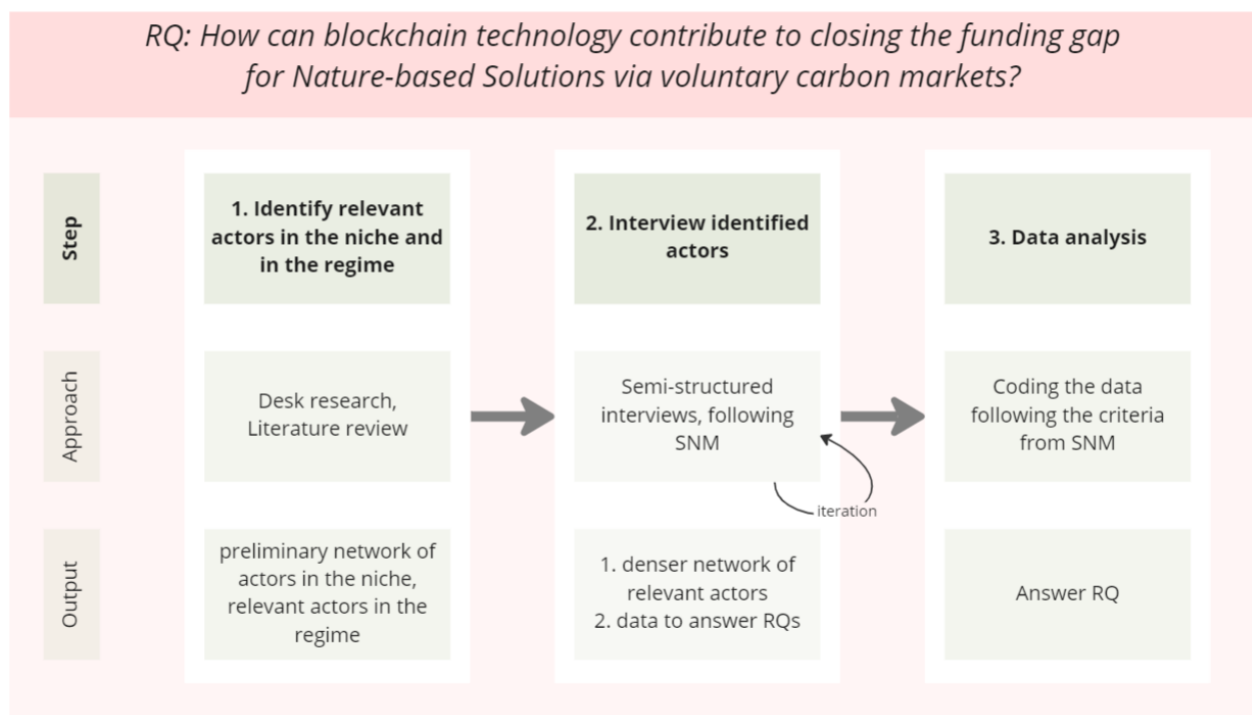


Figure 4: Conceptualisation of the research design. Own depiction.

Due to the research gap, conducting qualitative research, including semi-structured interviews, provides a useful starting point for gaining insight into how the niche is currently managed, and can guide future in-depth research on various categories within the subject area.

4.1 Data Collection

To get a comprehensive answer to the research gap, the chosen methodology was semi-structured interviews. Semi-structured interviews are a type of qualitative research method that involve a flexible, yet pre-determined set of questions designed to elicit in-depth responses from participants (Bryman, 2016).

The sampling strategy for determining the interviewees is purposive sampling. Purposive sampling is a non-probability sampling technique used in research to select participants based on a specific purpose or criteria that aligns with the research question or objectives (Bryman, 2016). The goal of the sampling strategy is to strategically gather different perspectives and experiences from stakeholders in the niche and the regime on the four upscaling patterns and the three processes classified in SNM.

4.1.1 Sampling Strategy – identifying relevant Actors in Regime and Niche

The starting point for identifying different relevant actors to interview is the desk research that was conducted for chapter 2. Different stakeholder groups (see table 4) were interviewed based on the assumption that different stakeholder groups have different experiences and angles of view on the niche, and can thus contribute to a holistic, less biased assessment of the niche.

When interviewing different actors, the sampling strategy is extended by the snowball technique, which is asking the interviewees about which relevant actors should contribute to shaping the research through being interviewed (Bryman, 2016). The starting assumption was that three interviews per category will be dense enough in information to assess the management of the niche and to cover all relevant perspectives, what led to 18 interviews in total.

Table 4: Stakeholder Groups in and adjacent to the niche

Stakeholder group	Relevance
Standards, registries, active in regime	Overarching, shaping actors.
Connecting organisations & Working groups in regime & niche	Connecting organisations, purpose: scale up the niche.
Investors in regime & niche	Practically involved in investing, pot. using novel technology
Project Developers & land stewards in niche	Practically involved in project development, pot. using novel technology
Start-ups in the niche	Practically involved in developing & scaling the technology
Startups in adjacent niches (e.g. web3 and NBS or NBS and carbon credits)	Close understanding of the niche but potentially different view than a company building within the niche Potentially pivoted away from one element of the niche or pilots within the niche

4.1.2 Operationalization & Question Scheme

The data used for the case-study analysis was gathered by interviews conducted by the researcher. The interviewees were chosen with the aim to get an overview on the niche and information on potential pushback or engagement between niche and regime.

In total, 18 interviewees were chosen, and the interviews were conducted in March and April 2023. Half of the interviewees were working on building technology in the niche, the other half was related to the niche in other ways. Table 5 gives an overview on the different groups and area of activities of the interviewees, and a detailed classification of the interviewees is in Appendix II.

Table 5: Summarising overview and some activities of the interviewed people. Approximate classification on activities of the stakeholders interviewed to give a better overview on the areas the stakeholder groups are active in.

Stakeholder group	People interviewed	Web3	Building Tech	Building Web3 Tech	ReFi working groups	Land Stewards Advocate	NBS	Carbon Credits
Web3 Technology Builders	9	all	all	all	some	some	most	some
Standard organisation	1	yes			yes		yes	yes
Connecting organisations, leading working groups	2	all			all		all	all
Investing in impact & Web3	2	all			some		all	some
Building centralised Technology, curiosity to Web3	3		all		some	some	all	
Project Developer	1	yes			yes		yes	yes

To have a solid data density, every interview covered all topics indicated in the interview guide in Appendix I and lasted about 30 – 60 minutes. The interview questions were designed to cover information on both the three experiment processes and on the four upscaling patterns, and are adapted by Naber et al. (2017). While all questions were asked, the elaboration on different topics varied per interview.

4.2 Data Analysis

The gathered data was coded in NVivo, and the coding scheme followed the experiment processes, the subcategories, and the upscaling pattern, to see if structures are present or not. Both the upscaling indicators and the processes were analysed with an exploratory approach. This was done through listening to the elaboration and the way interviewees spoke about them. If many interviewees mentioned the same patterns, they were assumed to be more present, and if interviewees were mentioning contradicting patterns, both sides were included in this research. Thus, this analysis is qualitative and not meant to be used for quantitative analyses or absolute statements. There were no quantitative scales introduced, as this would require comparing this case to other cases. Instead, this study is qualitative and exploratory, and maps the different mentioned processes, interplays and circumstances to offer follow-up studies a solid ground for more in-depth research.

4.3 Data collection, data handling and data storage: Ethical Matters

To ensure the data-sovereignty and anonymity of every interviewee, different measures were undertaken (Bryman, 2016; SRA, 2022). Written information on the content of the interview was be shared beforehand. The consent to record was asked at the beginning of each interview and the informed consent form provided by the Utrecht University was signed (Appendix VI). To ensure the confidentiality and anonymity of the participants, a unique code was assigned to each interview partner during the coding process. In instances where an individual's identification is necessary, explicit consent was obtained beforehand. Furthermore, in compliance with ethical standards, data will be deleted upon request.

5 Results

In this chapter, the findings from the 18 conducted interviews, that contribute to answering the research questions will be investigated. All the data was obtained and concluded through interviews that were conducted in March and April 2023. This chapter is divided into three sections, where each section deals with one research question.

The first section addresses the main RQ and explores the role of the blockchain technology in the socio-economic system around NBS & VCM. It goes into how the power of the technology alone towards closing the funding gap is seen, which other factors may play a role.

The second section addresses how the niche is managed, following the lines of the experiment processes SNM and thus deals with SRQ1.

The third section elaborates on the upscaling patterns, lack thereof, future expectations, critique and elements missing but needed to scale up the niche, which addresses SRQ2.

5.1 Blockchain and its potential for decreasing the funding gap for NBS

The first research question is how blockchain technology, NBS and VCM are interconnected currently and how the technology could increase the funding of NBS projects that are active on the VCM. This is an exploratory question, to understand the niche, the interviewees and where the interviewees see potential of the technology for funding NBS.

Many interviewees are seeing the most realistic scalable tool to fund NBS through the VCM and are working on how to make this financing mechanism efficient and sophisticated enough to create an asset class around NBS.

how do we increase the scale of financing that goes into these [NBS] projects. And we came to the same conclusion that although carbon credits are by no means perfect, they're one of the few scalable financing mechanisms we have, to reward land stewards for doing good things for the planet. - T1

Many project developers use the VCM as the main funding mechanism.

We will remain part of the voluntary carbon markets. And that serves as the key financing mechanism for us. – P1

However, barriers to funding NBS are plenty. Exploring the size and the edges of the funding gap for NBS, and how Blockchain technology can have a role in closing it, is done in the following chapter. Moreover, the identified gap in research is that there is little literature on how the blockchain technology can contribute to closing the funding gap for NBS projects that issue Carbon Credits and finance themselves through that.

With exploring how the technology can and cannot contribute to closing the funding gap, this study found that there are many different and interconnected underlying factors that lead to a lack of funding. The factors are: not enough money being invested into NBS projects, not enough

trust in both carbon markets and in blockchain technology, too lengthy certification processes, too expensive middlemen, lack of both demand and supply of high-quality carbon credits and an insufficient commodification of the market. These factors are listed in more detail in Appendix III.

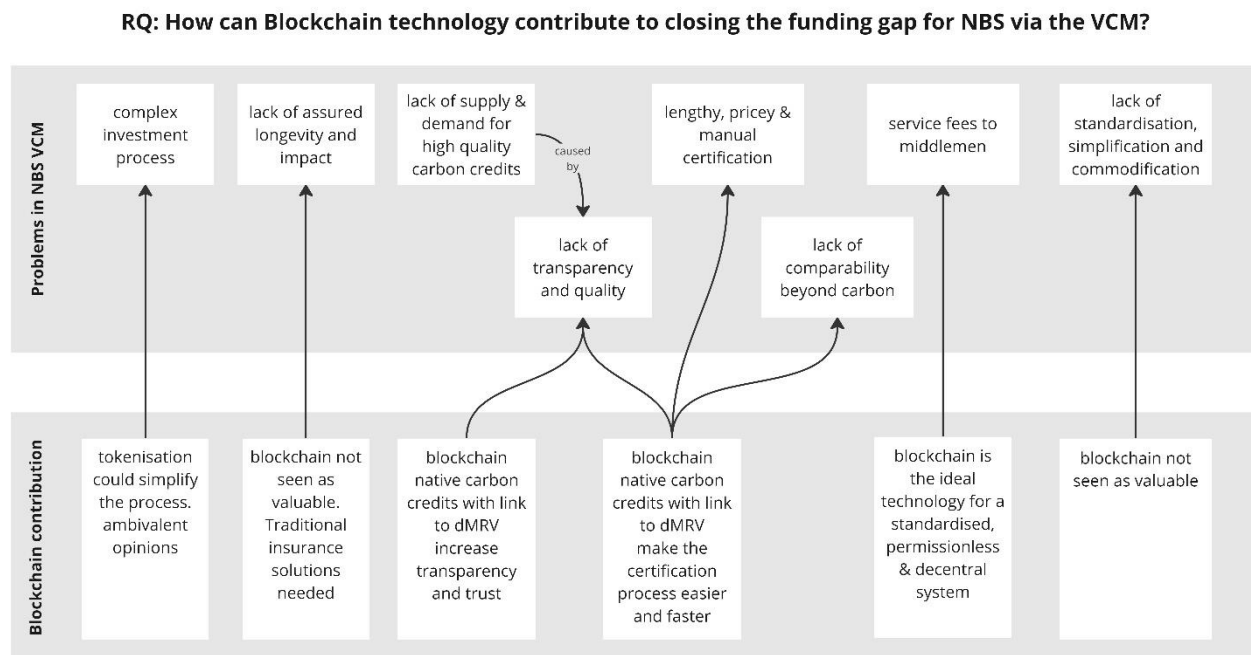


Figure 5: Barriers to funding NBS through the VCM and potential use cases of Blockchain technology to tackle these. Own depiction, based on the interview data.

Some interviewees see potential of the technology to **simplify the investment process** and thus increase funding.

The technology could contribute to closing the funding gap through tokenising the projects and formalising the investment process with smart contracts and having the tokens accessible through online marketplaces. The expectation is that then the accessibility and attractiveness for investors is increased, and more investment could flow into NBS projects.

blockchain is wonderful for financing projects. So early financing because you also have many because otherwise it's very difficult in the old legal system - W3.2

Others see the usefulness in theory but stress that it is not possible in practice yet to scale up upfront investments with the help of Blockchain technology.

what it [blockchain technology] can't really do is still help with developers like us to scale up rapidly get that upfront capital investment – P1

Others are critical towards upfront financing through tokenisation, because simplifying the investment process could increase the attached risk and could create more negative than positive outcomes.

this is kind of where the risk comes in, in a way, it probably does make it easier to invest upfront, and to do it in a generic way where you're buying a kind of a token. But that's where things have gone wrong in finance before where people don't really know what they're buying. – S1

To tackle the **potential lack of longevity and impact** of the NBS solutions, insurance solutions are seen as necessary to not repel customers and investors. For this topic, blockchain is not named as a promising key technology. Some interviewees stress that traditional hedging and insurance-solutions are needed more than blockchain solutions, with the purpose of building long-term trust.

I don't see the solutions in the Web3 area now, rather, as I said, hedging solutions are needed, traditional financial solutions and insurance solutions are needed. – W3.3

The **lack of transparency and quality**, which decreases trust of investors and buyers together with the **lengthy and expensive manual certification process** is tackled by different technology builders in the niche. Interviewees see a promising technology in **digital Measurement, Reporting and Verification of the impact claim (dMRV)** instead of audit-based carbon credits. In this field of topics, interviewees agree on that tokenisation of carbon credits can increase transparency and trustworthiness if the dMRV data is stored on a blockchain, and the carbon credit is blockchain native, thus registered on a blockchain as soon as or before being issued.

once that that trust is built, and this could be through, you know, more robust digital MRV – C2

Another cost factor with financing NBS solutions through the VCM is the **service fees of middlemen**. Through a standardised and permissionless system provided on a blockchain infrastructure, some interviewees hope to bring the costs of middlemen significantly down. Blockchain is an excellent technology for such a use case.

It would be exciting if the costs of intermediaries could be brought down to five percent or ten percent. – T2

Many interviewees suggest that while blockchain technology may not be a necessity, having the data on-chain could enhance accessibility and digitization, leading to improved comparability and better judgment on project quality, thereby potentially increasing trustworthiness. This could lead to both **increased supply of trustworthy carbon credits, and increased demand for the same**. Creating a transparent digital infrastructure for supply chain tracking, particularly utilizing blockchain, is one approach discussed to increase trustworthiness. Additionally, digitalizing metadata and impact of NBS is considered as a potential solution for facilitating user-friendly comparisons and addressing the challenges in selecting trustworthy carbon credit projects.

There is both the option to **standardise carbon credits** without taking metrics beyond stored carbon into account, and to **make the impact beyond carbon comparable**. While tokenisation and digitalisation can help with commodifying a market, it is not necessary because all the traditional commodities are traded in a non-tokenised way.

Whereas some interviewees are convinced about **commodifying the carbon credit market**, it is important to keep in mind that an overly heavy focus on carbon exists and that there are planetary boundaries that humanity is about to exceed other than climate, and that it is important how trade-offs between climate, biodiversity and local communities are, and how a commodification of one of the benefits of NBS – carbon capture and storage – could harm the implementation of other benefits. With this knowledge, others see with blockchains a way on quantitatively capturing the multiple dimensions of NBS-originated carbon credits.

having a blockchain standard that's multi-dimensional, which is one of the things blockchain can't do like the carbon credit market is standardized throughout one tonne of carbon only. So the ability to add equity, biodiversity, water rights, soil quality to that tonne, is something only blockchain can do - W3.9

Others see commodification and the idea of **turning nature into an investment product** as critical because of the risk that a potential lack of demand could lead to falling prices, and thus to less implementation and maintenance of NBS projects. Alternatives explored by some of the interviewees are to make NBS not a commodity and have the resulting tokens not traded, but only allow to expire, thus to consume them.

But I see greater potential even in the fact that one manages to move from a financial product to a consumer product. Because investing in nature is an intermediate solution. – W3.2

5.2 The State of the Experiment Processes within the researched Niche

To answer the first sub research question – How is the niche of using blockchain technology for financing NBS through using VCM managed? - interviewees were asked about the three different experiment processes from Strategic Niche Management – Social Network Building, Articulation of Visions, and Learning Processes. The following section maps out how the state of these three different, interdependent experiment processes is perceived to be and described by the interviewees. It is structured by the three experiment processes.

There seem to be many players in the niche, and the niche seems to be very active with a lot of companies wanting to do business in that niche.

There is a lot of movement in the space. So there is a lot. So everyone always wants to do something with everyone else. [...] There are about 150 or 170 companies in various forms. – W3.3

SRQ1: In which state are the experiment processes within the niche of using blockchain technology for financing Nature-based Solutions through using VCM?

Experiment Process	Social Network Building	Articulation of visions and expectations	Learning Processes
Findings	Working well in principle, some competition in place, founder-dependent, connecting organisations & working groups in place that are successful unless the idea about the vision is in the way	Very principled, very articulate, sometimes hinder collaborations when the underlying visions about how to reach the goal do not match	Amongst technology builders: seem very dynamic, lots of learnings about the technology, the narrative & the business models are happening Amongst project developers: seem to be barely in place

Figure 6: The three experiment processes according to Geels' Strategic Niche Management and their state in the researched Niche. Own depiction, based on the interview data.

5.2.1 Social Network Building

The first experiment process, social network building, which is further classified into being broad and deep, is perceived differently by different interviewees. One group of interviewees stresses that there is connecting organisations with the aim to connect and strengthen the ecosystem around companies applying blockchain technologies for climate such as the ECOTA or Climate Collective, and many organisations are initiating or participating in working groups to different topics such as tokenisation or dMRV, also from established players like the World Economic Forum or the carbon credit certifying organisation Gold Standard. Some of these working groups reached their intended outcome and are succeeded by a next working group going more in depth on a specific topic. Thought leadership is emerging out of these working groups. Players seem to be well-connected and willing to collaborate, and there's a lot of imaginary and technical collaboration.

Verra and gold standard launching their working groups around tokenization. They also have working groups around digital MRV [...] We see groups like the blockchain and Climate Leadership Network emerging, we see the Ethereum climate platform. - C2

Some working groups and collaborations are successfully coordinated from within the niche.

especially in the blockchain space, and in Web3 is a lot more coordinated effort - C2

One interviewee stresses that despite high levels of collaboration, there's less need for social network building and active collaboration in Web3 due to the permissionless technology & open-source approaches. Open-source protocols and permissionless systems foster technical interactions, allowing stakeholders to engage without the need for agreement on all aspects. There is the idea that articulation of visions is needed less due to blockchain and its open source and permissionless nature.

we collaborate with everyone. [...] they found a way to take that data from the blockchain and said, hey, it's very simple to actually access it, we super happy. So it's, it's not like an open contract sign - W3.1

Other interviewees perceive the collaboration as highly competitive and very individualistic, and not much connection, and there's the remark that that is needed to create novel ideas and that a certain competition is healthy.

There's not a lot of strong connecting. There's a lot of competition. – I2

the vibe is just like any other high competitive startup market, I've been part of 10 or 12. I mean, I'm a technologist. So I, I know all of these markets, everything from quantum computing to, to blockchain - W3.9

Another perception is that the collaboration is rather superficial and held-back because all players are waiting for the general direction of the market before committing to deep collaborations into a specific direction.

Everyone just stands at the sides, and no one's doing anything. [...] everyone's checking each other out. Not really understanding what moves are gonna happen and who's going to make progress quickly - W3.4

These views on social network building all refer to connections between technology builders. There is the notion that there is no collaboration and a disconnect between technology builders or carbon project developers and the land stewards.

in these places, there are ways to implement tokenization. But you first have to get past that hurdle of like actually having the basic infrastructure. So yeah, that's, that's a huge problem that people overlook. – I2

Furthermore, there is a disconnect between the decision and policy makers (often headquartered in the global north) and the land stewards (in the global south).

The decision makers and the policy makers are unfortunately disconnected from the people on the ground, especially here in Africa. - W3.8

Amongst the project developers, there seem to be a lot of connections and collaborations.

Umm, I was quite pleasantly surprised because a lot of these project developers are actually friends. [...] I think they're very well interconnected. - T3

5.2.2 Articulation of Visions and Expectations

The interviews shed light on articulated visions and expectations within the carbon credit industry. A common vision emerges among the interviewees, emphasizing the aspiration to bring positive environmental change and recognizing the transformative potential of the market.

the real underlying vision that the market can make a difference to our planet, I think we all share this. - C1

Despite a shared vision, emotional disagreements, and diverse perspectives on operationalization hinder collaboration. Challenges arise in articulating visions and expectations, particularly when there are divergent views on the pathway to shared goals. Additionally, a sense of idealism among niche players may hinder the development of deep social networks and collaborative efforts. This points towards elaborate articulations of visions.

in our working group meetings, that there are very emotional disagreements on the way there, very emotional disagreements, how the way there should be designed, also in the VCM. - C1

5.2.3 Learning Processes

Learning processes in SNM are divided in broad and reflective learning processes. With the interviews, it was found that the interviewees reflected both on individual learning processes and general learning processes of the niche.

It seems like there's a lot of learning happening, people are articulate about the broadness and the reflectiveness of their learning processes and the learning processes of the ecosystem, and some even map it out over time. Furthermore, some interviews walked through the dominant narrative within the niche and how it changed in the past years and how they expect the narrative to change, which shows that the niche seems to learn.

the whole narrative at the beginning was really about transparency, fragmentation of market, opacity of market. [...] And then starting from that, then people started to look at, hey, actually, there are other problems, traceability, so the digital MRV topic is something that grew a lot last year. – W3.5

There were different dynamics described where the niche is learning a lot and the openness to learning depends on the part of the value chain. Learnings go both in the technical and in social area, and into the interconnection of both. There are coordinated efforts to learn collaboratively in working groups, and they are seen as a valid space for learning and knowledge exchange (See section 5.2.1 – Social Network Building).

Learnings amongst project developers seem to be barely present, and learnings amongst standard organisations seem to be slow and hesitant.

For it [the market for project developers] being so new, they use such outdated mechanisms - T3

A detailed list on quotes and explanations of different learning processes can be found in the table in Appendix IV.

5.3 The State of the Upscaling Processes in the Niche and Strategies to Scale up

The second sub-research-question is which upscaling patterns are in place and which processes need to be strengthened or employed to effectively scale up this niche and contribute to close the funding gap. This is approached with looking at the presence and scale of the upscaling patterns from SNM.

The upscaling patterns according to SNM are growing, replication, accumulation, and transformation. This research found that the upscaling patterns Growing, Replication and Accumulation start to be present, whereas the pattern Transformation is not in place yet. Often, the interviewees explained what was lacking for scaling up and why they think the niche is not scaling. Thus, the first part of this section elaborates on the state of the upscaling patterns as a group, and the second part elaborates on the expected and needed development of the upscaling patterns.

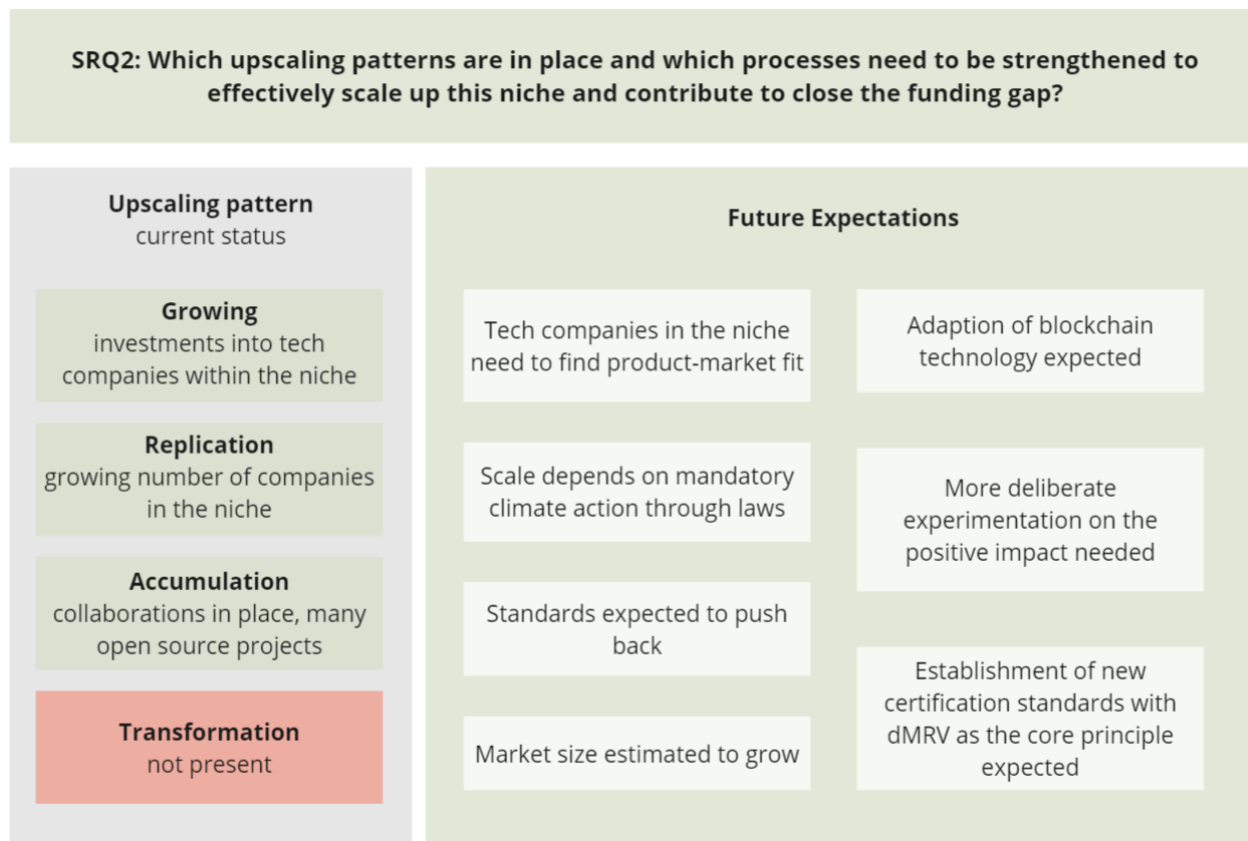


Figure 7: Overview figure on the status of the upscaling patterns and the expected or said to be needed outlook for factors playing into the upscaling patterns. Own depiction, based on the interview data.

5.3.1 The current state of the upscaling patterns of the niche

The upscaling patterns Growing, Replication and Accumulation were found to be present, whereas the pattern Transformation was not in place. The following section goes into the different aspects of the status of the upscaling patterns.

There is **growth** happening within the niche **in terms of investments** to tackle the inefficiencies in both the VCM and in NBS and in NBS originated carbon credits, as well as investments in tech companies that work with decentral technologies.

half of the market at the moment are startups from the last few years, because there's been a huge increase in investment coming through. – S1

Beyond that, there are many new emerging companies in the niche, which points towards replication and accumulation happening.

There are about 150 or 170 companies in various forms. – W3.3

The market is framed as small and nascent, and said to be too small to have an influence on the regime.

In the way we scale this market further to a size where it can really make a difference, which is actually the basis of the whole market, but for which it is currently far too small. In the Voluntary Carbon Markets 2021, it was at around two billion. – C1

Furthermore, it seems to be very inefficient due to its size and due to its historic development as a side product of either forestry companies or created by donation-based NGOs.

it's one of the most inefficient markets on the planet. – W3.9

Due to the size of the niche, players in the niche do not seem to have any influence, but dialogues and exchanges with the regime are happening.

I don't think we've had much influence. I mean, we've been to many workshops, where Verra will be there, and we've had discussions [...] I know that all the projects in the ReFi space refi being defined as a whole kind of set of projects, have, you know, active and really engaged conversation with those standards. - W3.1

Transformation patterns seem to not be present at all.

*Author: do you think they managed to nudge transformation already?
Interviewee: No, no, no, no, not at all. - I2*

I don't think we've had much influence. - W3.1

And there is no presence of smallholder farmers or land stewards in the market despite of them being a valuable force in effectively implementing NBS and eventually scaling the issuing of carbon credits.

The majority of people on the market if they're doing NBS, are logging companies, so there's like virtually no market presence for the people who actually own small farms in the jungle. Those few target with Savimbo that when I see a market like that, I see it's ripe for disruption. – W3.9

The shared notion is that there is growth, replication and accumulation happening, but it is **too early to estimate if these upscaling patterns can be sustained**.

because we, I have personally haven't seen the whole cycle play out - P1

5.3.2 Current developments, and assumptions what is needed to scale the niche

After capturing the state of the upscaling patterns, the expected and assumed to be needed future developments concerning the niche's upscaling patterns are investigated.

Some areas of topics that are worth to explore or to implement to eventually create transformative impact were laid out in the sections 5.1 and 5.2, this section goes further into current and expected future developments concerning the niche's upscaling patterns.

While the transformative upscaling pattern is not strongly present yet, many interviewed people are positive about the market scaling and being transformative in the future. The positive sentiment is rooted in different observations.

While there does not seem to be many companies that have reached product market fit yet, many are now pivoting to target corporate customers instead of targeting individual customers to reach a **bigger market**.

But a lot of them haven't really figured out the right product market fit. - P1

Digital MRV is assumed to disrupt the market, as it is scalable at little cost, and adds transparency and granularity to the data that was not present before.

So the MRV is going to become central, it's already kind of central, in the quality of the carbon credit – W3.1

The certifying companies are said to have a backlog from up to 2 years until they have certified a project. They audit and certify projects based on reports of their consultants, which is costly and slow and makes it infeasible for smaller communities or project developers to issue certified (and thus more trusted) carbon credits. Digital MRV has at least potential to cut their working effort and their costs, and will at best have the potential, together with other innovative approaches such as community-based certification and verification on the ground to replace current monopolised certifying companies.

it's worth looking at the Digital MRV stuff because that's that's looking at exactly how all of this can be done – S1

One standard organisation is even working on using dMRV beyond making the process more transparent and efficient.

we're interested in how technology can support the project developer themselves, rather than just make it more efficient or transparent – S1

The adaption of web3 technology is estimated to grow. Many interviewees assume that the technology will eventually be a tool that is used in the backend (the part of an application that is typically not seen by the user), and that the end consumers will have seamlessly smooth interfaces to operate with, whereas now some web3 based technology may have bulkier interfaces compared to centralised applications. Furthermore, it is estimated that companies will both not know on which backend the product is built that they are interacting with, and that the trust to products that contain web3 technology will grow.

I think it'll become more of a backend play. - W3.9

The expectation that centralised, established companies – the socio-technical regime will continue to **push back** against decentralisation and against transparency, with the assumption that they do not want to lose their current business models.

they also have a self-preservation instinct, and that naturally stands in the way of innovation. That is always the self-preservation instinct of the dinosaurs – W3.2

The **market size is estimated to grow** to an influential size by 2025 from the current \$2 bn, and it is estimated that with a growing market size there will be new standards that are seen as reliable.

until the market has scaled to a size where it can really have an impact on humanity, we will need until 2025, until we have standards that institutions can rely on. - C1

Another assumed development is that the market around w3 carbon credits will **scale as soon as climate action is rooted in mandatory policies and laws**. The reasoning behind that is that currently, being active on the VCM is already a voluntary action, that often happens out of goodwill, and then going for transparent, digital carbon credits that are originated in NBS would be asking one step too much and will become the new thing to do out of goodwill as soon as carbon emission compensation is more regulated.

The only reason people are participating in the voluntary carbon market is not because they care. Sadly, well, some do, 90% don't. 90% are just answering to their customers pressure to change. - I1

Some interviewees raise the idea that it may be good to **not build the system decentral initially** but design the systems centrally first until they are solid and then they can be put on a decentral system, because then it is easier to adjust and pivot if needed.

if you build this bulky system on a blockchain, you might also block fast innovation and adaptation of such systems, especially in the early stages. – T2

Another often-shared view is that with this early market a lot of **deliberate experimentation** is needed to not destroy the communities of the land stewards on the ground. For this, patience, and thus a form of financing that enables that would be beneficial.

I think something like community inclusion, and, and governance requires a lot of patience, and a lot of slow work. And that that slow pace can be painful at times, but it's really important sometimes. So I don't know that, that venture capital is necessarily the best form of finance for community level work [...] can you create shared assets shared benefits that people can mutually invest in and reduce the risk for everyone, but unlock new capital? - C2

Concluding this view, it is stated to be good that the niche has no transformative impact yet, because there is a need to get a larger understanding of the implications of things and connections before the market can be scaled. It is judged as right that big players and connecting organisations in the niche are forming working groups to explore the implications to eventually scale up in an efficient and effective way.

Another remark was more nuanced concerning the dMRV and streamlined investments through tokenisation. Speeding up the investment process and making it easier and more accessible needs to be designed in a careful way to not create more risk. The reasoning is that having investments more accessible and having the dMRV faster and easier than the manual expert approved certification might bring down the quality of the carbon credits and increase the risk of the investment.

this is kind of where the risk comes in, [...] in a generic way where you're buying a kind of a token. But that's where things have gone wrong in finance before where people don't really know what they're buying. – S1

A more detailed overview on different sentiments and situations that hinder scaling or elements that are missing for transformative upscaling processes can be found in Appendix V.

6 Discussion

This chapter presents the key findings and implications of the research on the role of blockchain technology in funding and scaling nature-based solutions (NBS) within voluntary carbon markets (VCMs). The results are presented primarily in a descriptive manner, providing a comprehensive overview of the observed data and characteristics without drawing in-depth inferences beyond the collected information. The chapter focusses on the importance of learning and collaboration within the niche to unlock the technology's full potential and develop effective use cases. This descriptive study highlights the significance of well-designed systems and governance structures, which are crucial to harnessing the capabilities of blockchain technology in addressing market failures and financing NBS projects. Moreover, the complexities of innovation processes within the niche are explored, focusing on social network building, articulation of visions, and the changing narrative, shedding light on the challenges and opportunities for successful scaling. By examining the funding gap and potential risks associated with carbon credits, the need for continued research and collaborative efforts to foster sustainable and transformative outcomes in the realm of blockchain technology and NBS is underlined.

6.1 Benefits for the NBS & VCM sector through Blockchain technology

There is consensus amongst the interviewees that there are different ways in which blockchain technology can play a role in tackling the funding gap for NBS and carbon-credit issuing NBS. However, it is important to note that using the technology alone is not the solution. Beyond using the technology, it is important that the systems are designed and implemented in a way that they tackle the flaws of the market. The technology can contribute to tackling the flaws but is not the only way to work around the flaws.

The risk pointed out by Lamb et al. (2020), that voluntary markets are non-transformative because the carbon credit buyers do not have strong incentives to change their behaviour is not seen as a strong risk by the interviewees. Much rather, VCMs are seen as a faulty but yet the best tool to bring financing towards NBS.

As stated by previous reports (AFME, 2022, p. 9; UNEP, 2021), the lack of funding is rooted in market failures such as over-exploitation of common access resources and the lack of remuneration for public goods and services. A coherent system to measure and monetise the impact of NBS is lacking. This study found that blockchain technology can help overcome these failures.

Beyond that, this study found that there are more nuanced underlying factors that lead to a lack of funding, such as costly and timely certification processes, expensive middlemen, a lack of comparability between projects, a lack of trust in carbon credit issuing NBS projects, and difficulties in financing carbon credit issuing NBS projects upfront. The study found that blockchain technology can help tackling some of these underlying factors.

The interviewed people are aware that blockchain technology is a tool and not the single best solution, and to create the best outcomes, the technology needs to be paired with thought-out systems design. Interviewees are working on designing the systems they are operating in

purposefully through their ventures or activities and seem to be aware when to use the technology impactfully and when not.

This study did not find significant differences to previous and with these findings, this research contributes significantly to the literature on financing NBS.

6.2 Active and dynamic experiment processes

The different experiment processes in niche seem to be present and working well. The overall sentiment towards them is positive, however, there is differences in the views upon them, that can be explained with individual perceptions.

The **Social Network Building** seems to be well in place, but the activeness depends on the individual. Beyond building social networks, sometimes, ideological views on how to implement certain ideas are sometimes hindering collaboration despite of a shared vision. Another interesting remark is that social network building is less relevant in the niche around Blockchain, VCM and NBS due to the permissionless and open-source nature of many blockchain projects and company's products.

The articulation and sharing of **visions** seems to be in place and many players seem to be aligned on the overall vision. However, often they have different ideas on how to realise a vision, and the differences in the ideas on implementation lead to less collaboration.

The narrative within the niche seems to have changed, which can be interpreted that the niche is in a **learning** process. While conducting the interviews, many interviewees did not only talk about learning processes they or the niche underwent, but also about observations of which learnings will or should happen in the future. This can be interpreted as that people are well aware of potential trajectories and current flaws. At the moment, some interviewees stress that the learnings are stagnating, many know which the flaws are, and which learnings should happen, but most players wait for the niche to move into a general direction before committing towards a new direction themselves.

There was no previous research on the innovation processes within the niche. Looking at the experiment processes, the interviewees in general agree that the three experiment processes from SNM are relevant for the innovation niche to grow. There is the notion that some of the processes are highly dependent on the founder and cannot be generalised for the ecosystem.

However, while talking about the social network building and the articulation of visions and expectations, some interviewees question if the permissionless and open-source philosophy that many ReFi-companies follow reduces the need for them to be in place while having a niche successfully growing and scaling. The rationale behind this is that through the open sourcing and permissionless structures, there is less need for active alignment while still sharing resources (Maxwell, 2006).

New insights for understanding the processes in the Refi niche are that the niche learns well and collaborates well. The understanding of the state of the processes and which elements are needed for future learning is essential to further research of how the technological niche around blockchain technology, VCMs and NBS is evolving and can be ready to scale.

Blockchain technology, VCMs and NBS are different socio-technological innovation niches in themselves, and it is especially interesting to look at the intersection of these and research how learning and innovation can happen at the nexus of different niches and thus this research contributed to the stream of literature on Strategic Niche Management as a framework to manage technological niches and innovations.

The idea that less coordination is needed due to the permissionless approach of some companies in the researched niche and how this would alter synergy effects could be an interesting field to be explored further in future research.

6.3 Emerging upscaling patterns within the Niche

The interviewees are in consensus that the niche shows the upscaling patterns growing, replication and accumulation. However, it is not scaling with a transformative impact and does not have a significant influence on the socio-technical regime yet. It seems like many companies within the niche are still looking for a business model, which is the prerequisite to sustainably scale.

However, the interviewees agree on that it would be good if the niche scales in a way that also creates positive societal and environmental impact. There are some aspects in both the technology, the functioning of the system and creation of impact that need to be understood, and the value proposition needs to be clearer before the niche can – prematurely – start to scale, and in the worst case create negative impact.

The biggest hurdle for the niche to be transformative is the acceptance of blockchain-native, dMRV certified carbon credits from the market-leading standards, because buyers want to have verified or certified credits.

The criticism that carbon credits that are originated in NBS projects can lead to neo-colonialist structures got reinforced by this research. Previously, Howson (2021) found this risk and interviewees for this research state the same concern. The risk of relying on market logics instead of setting up the governance structures to tackle a problem (Atzori, 2015) is seen by many interviewees, and many interviewees observe deliberate effort to mitigate that risk through the right systems design.

The large funding gap for NBS is reported upon before (UNEP, 2021) and a lack of scaling in the ReFi niche seems to support the fact that there is a lack of funding for implementing NBS.

This research confirms that the funding gap for NBS is existent and a problem. While this is the case, this research also found that it is good that this specific niche – with one of the purposes to make the process around NBS more efficient – does not have the transformative upscaling pattern yet. This is the case from three angles: from the perspective of land stewards, it is good when the niche scales only after it is clear that the way of scaling won't further damage land stewards. From the perspective of risk aversion in investments, it is framed as good that the market is not scaling yet, because the comparability and the risk-levels should match the type of investments. From the perspective of technology builders, the added value of the products should be clear before scaling.

Comparing how the upscaling patterns are described by the interviewees to the findings of Naber et al. (2017), the research shows that upscaling patterns are partly active. However, this research finds that the upscaling patterns growing, replication and accumulation can be temporary and part of a hype. This research contributes to understanding the upscaling patterns and the lack thereof in the researched niche. There are several needed processes described that are assumed to be needed for the niche to scale in a transformative way.

6.4 Limitations of the research approach

The chosen research approach attempts to give a detailed overview on processes that are happening in the company ecosystem around Web3, Carbon Credits and NBS. This research is meant to be understood as a first map of the space and opens up the possibility to go more in depth on different researched topics. This research cannot be used as a complete representation of the niche, and not as a prediction for how the market will emerge.

While the research provides a broad overview on the innovation niche and elaborates on the different experiment processes and upscaling patterns, it lacks comparability to other spaces.

While the current patterns that are existing or not existing can be an indicator of how the space is doing, success of an innovation niche does not only depend on the actions of the niche, but also on actions and developments of the socio-technical regime and landscape. Thus, this research is not a prediction on how the niche will develop and scale. Furthermore, the granularity of this research focusses on the niche in its whole, and not on individual players that have activities within the niche or adjacent to it. Thus, the success of individual companies can be greater or less great than the success of the overall niche, and while the success of individual companies may come to be with some of the SNM patterns & processes present, variables to determine the success go beyond it.

This study reflects the sentiment of the interviewees in March and April 2023, and cannot be seen as a static and objectively true statement. Rather, it needs to be seen as a snapshot. Despite of the meticulous analysis approach of the author, this research is dependent on the researcher's interpretations of the data. Thus, the research cannot be fully objective. Furthermore, the question if the niche needs to be intact as a whole or if a single company – if successfully scaling – can be enough to scale up the innovation is open.

This research does not answer the fundamental, ethical question on whether carbon credits, and the underlying “asset” – nature – should be commodified and be governed by market logics. Other research investigates this topic and there's exciting research towards how nature can be governed along the lines of Ostrom's principles of the commons (Rozas et al., 2021).

This research also does not go into another fundamental, ethical question on the granularity of the quality of the data when it comes to carbon credits, and if the quality and thus the price of carbon credits should be determined by factors beyond carbon. Some researchers point out the risks that come with an overly focus on carbon while neglecting other planetary boundaries, and the optimisation towards carbon capture only while neglecting other factors such as biodiversity or the health & social intactness of local communities. If carbon credits should be commodified like oil – where one carbon credit equals one carbon credit no matter the negative or positive

impact beyond carbon – is a fundamental question that likely can be answered using different philosophical and ethical frameworks. But this development would need to be steered not only by market developments and entrepreneurial efforts but by regulation and legislation.

When talking about both carbon credits and blockchain technology, the question about the energy use (and thus, the potential use of fossil fuels) of the technology arises. However, the energy use of a blockchain depends on a couple of factors. The first factor is the consensus mechanism, and there are consensus mechanisms that use substantially less energy than others (proof of stake vs. proof of work). The second factor is the amount of transactions, and thus the quantity of the consensus operations needed. This is highly case-dependent and requires own research.

In conclusion, the results obtained from the rich data exceeded the researchers' expectations and is offering comprehensive answers to all three research questions. Despite the acknowledged limitations, these findings substantially contribute to the existing body of research in the field.

6.5 Recommendations for future Research

Based on the findings of this study, several recommendations for future research have been identified. Firstly, exploring idealism within the blockchain-NBS niche and comparing it to other niches may offer insights into the role of idealism in hindering or facilitating collaborations and impact. Secondly, examining the importance of interaction and social connections in open-source, decentralized, and permissionless knowledge networks can elucidate their influence on innovation within the NBS financing domain.

Furthermore, it is essential to analyse the potential impact of blockchain technology relative to other levers such as technological, governance, and societal solutions in closing the funding gap. Understanding how future learnings can be strategically acquired will enable effective adaptation and growth within the niche. Additionally, exploring the dynamics between regimes and niches and identifying the specific areas where blockchain technology offers a substantial edge over centralized digital solutions will be crucial for informed decision-making.

7 Conclusion

This academic study aimed to explore how blockchain technology can contribute to closing the funding gap for Nature-based Solutions (NBS) through voluntary carbon markets (VCM). The research findings shed light on the potential of blockchain technology in this context, offering insights into the management of the niche, potential upscaling strategies, and its implications for the broader field of NBS financing.

For this study, interviews were conducted with people working in or in close relation to the innovation niche around funding NBS through VCM & blockchain technology. The study found that blockchain can indeed contribute to closing the funding gap for NBS through VCM, albeit with some limitations. While the technology shows promise in addressing certain aspects contributing to the lack of funding, it is not a comprehensive solution in itself. The results suggest that blockchain's application within VCM will eventually help close the funding gap by enhancing transparency, accountability, interconnectedness and efficiency in the process through blockchain-supported dMRV, blockchain-native carbon credits, and reducing middlemen throughout the life cycle of carbon credits.

The investigation into the management of the niche using blockchain technology for financing NBS through VCM revealed a positive outlook. Stakeholders within the niche appeared to be well-aligned and collaborative, working together to explore the potential of blockchain applications for NBS financing. However, it was also noted that the market is still in its nascent stages, implying that significant developments and challenges lie ahead in fully realizing the potential of blockchain technology for NBS financing.

The study explored potential developments helping the niche to scale up and transform the regime and contribute to closing the funding gap for NBS. It identified the need for extensive learning within the niche, recognizing that certain challenges and opportunities must be addressed for effective upscaling to occur. Upscaling patterns were found to be underdeveloped, reflecting the early stage of the market, and suggesting that more time and experience are required to identify effective upscaling strategies.

Overall, the research process was deemed successful, providing a valuable overview and snapshot of the current state of the blockchain-NBS niche. However, it was acknowledged that the study's scope had its limitations, particularly concerning predicting the long-term development and impact of blockchain technology in this context. The uncertainty arising from the interplay between technology, regimes, and landscapes adds complexity to assessing blockchain's potential effectiveness in closing the funding gap. Nonetheless, the research provides a solid foundation for future investigations in this field.

As potential areas for further research, we suggest exploring idealism's role in collaborations and impact within the blockchain-NBS niche compared to other niches, investigating the importance of social connections in open-source knowledge networks, analysing blockchain's impact on closing the funding gap relative to other solutions, and identifying areas where blockchain technology excels over centralized digital solutions for informed decision-making.

This study contributes new knowledge by providing insights into the management and potential of blockchain technology for NBS financing through VCM. It emphasizes the early stage of the

niche, the need for continuous learning, and the promising aspects of blockchain technology. As a takeaway, it cautions against viewing blockchain as a silver bullet solution to the funding gap but acknowledges its potential contributions when thoughtfully integrated into NBS financing mechanisms.

In conclusion, this study has demonstrated the potential of blockchain technology in closing the funding gap for Nature-based Solutions via voluntary carbon markets. It provides valuable insights into the management of the niche and identifies areas for future research. By understanding the limitations and opportunities, policymakers, practitioners, and stakeholders can collaboratively work towards realizing the full potential of blockchain technology in funding NBS and addressing environmental challenges. The findings of this study contribute to the broader field of sustainable finance and highlight the significance of continuous exploration and learning in leveraging blockchain for environmental solutions.

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Appendix I: Interview Guide

Introduction	Purpose
	Introduce myself and the research Ask for consent and ask if the interview can be recorded
Broader topics to understand the niche	Exemplary Questions
Blockchain, VCM & NBS	What are your general expectations on VCM, tokenisation & NBS? <ul style="list-style-type: none"> • Societal • technological
NBS & VCM	How do NBS & VCM interplay? Does the VCM influence funding that goes into NBS? <ul style="list-style-type: none"> • in the past? • now? • in the future?
Blockchain applications (e.g. tokenisation) for NBS Projects for increasing investments	In your perception: does tokenisation of NBS projects influence funding that goes into NBS? <ul style="list-style-type: none"> • in the past? • now? • in the future?
tokenising VCM - Carbon Credits for funding NBS Solutions through selling Carbon Credits	does tokenisation of carbon credits influence funding that goes into NBS projects? <ul style="list-style-type: none"> • in the past? • now? • in the future?
Experiment process	Subcategories Exemplary Questions
Social Network Building	Broad Which different groups of institutions does your institution interact with?
	deep How do you collaborate, how often do you meet, which timely and financial resources are committed?
Articulation of visions and expectations	Articulation Are the expectations from each member spoken out? Do you have the impression that they are not?
	Robustness Did you have differences with other stakeholders in terms of expectations? Do you have differences now?
	Quality Do you act based on your expectations? Are you meeting your expectations through shared action, research, or findings from working groups?
Learning Processes	Broad What did you learn on the technical side? What on the social side? What did you learn about the connection, and how are the learnings balanced?

Reflective	What was the problem definition and assumptions you started with? Did it change? If so, can you walk me through the changes?
Upscaling pattern	Exemplary Questions
Growing	How did your initiative grow in terms of users and customers? How in terms of revenue?
Replication	For technology providers: How is your competition? Do you see other people replicating your core concept? If so, whom? How? For connectors: How do you see successful initiatives being replicated? Which ones, from whom, how?
Accumulation	How did your network of collaborators grow? Are you in working groups? In which ones? How committed are you, how do you perceive the working group concerning alignment, output and ability to pivot?
Transformation	Where do you see that you managed to influence the non-tokenised VCM? Where do you face barriers in doing so?
Wrap-up	Purpose
	Thank you for the time and the insights, next steps

Appendix II: Interviewee overview & classification

Classification	ID	Interview in German	Date (in 2023)
Web3 Technology Builders	W3.1		April 21 st
	W3.2	Yes	April 5 th
	W3.3	Yes	April 5 th
	W3.4		April 3 rd
	W3.5		March 31 st
	W3.6		April 5 th
	W3.7	Yes	March 27 th
	W3.8		April 5 th
	W3.9		April 24 th
Standard organisation	S1		April 19 th
Connecting organisations, organising working groups	C1	Yes	April 3 rd
	C2		April 6 th
Investing in impact & Web3 & ReFi	i1		March 30 th
	i2		March 24 th
Building Technology, curiosity to Web3	T1		March 30 th
	T2	Yes	March 30 th
	T3		March 27 th
Project Developer	P1		March 31 st

All interviews were conducted by Dorina Döring. Interviews were conducted in English unless marked otherwise in the table. The interviews conducted in German were translated by the author. The interview transcripts are available upon request.

Appendix III: flaws in the current NBS VCM system

source: interviews conducted for this study

Area	Explanation	Citation
Lack of money available for the projects on the ground funding	Operating under a donation-based paradigm & thus not interesting for investors	<i>most of the players are small scale regional nonprofits, who are sort of used to working with philanthropic capital, so they are used to taking the money and spending it without actually being held accountable – P1</i>
	Project developed in politically & economically unstable areas as a risk factor for investors	<i>being based in a country like Myanmar, even though they were actually a Norwegian NGO they have a lot of challenges with accessing finance - W3.6</i>
	VC capital not the most suitable type of capital, new forms of more patient capital needed for community-inclusive projects	<i>[VC funding] is not right for everyone at every stage. So maybe we think about different financial structures that can enable more discovery and iteration [...] like grants or more patient capital - C2</i>
Lack of trust in the VCM	Related to the manual certification process.	
	originated in both a lack of transparency and quality control of projects, and a lack of either longevity & impact of the project, or of insurance for the case that the promises cannot be held.	
	corporate buyers of carbon credits would risk their reputation if they do not get the bought climate compensation	
	Problem that impact often cannot be tracked	<i>the problem we identified around like climate financing for carbon sequestration, is [how ...] existing institutions [can become] hopefully more credible, in terms of how impact can be verified, validated, certified, monitored, tracked. - W3.6</i>
Certification process	upfront financing not only needed to buy the land and do the labour, but also to get certified with the lengthy & expensive certification process	<i>project financing is very expensive, that is, they have to raise a few million for it. [...] the certification process is ultra expensive and takes a long time. – W3.7</i>
	This is a hurdle especially for small landowners or project developers	<i>it's hard for project developers, especially in global south or small projects, small farmers, small landowners to access actually the carbon credit [...] because it just costs too much - W3.5</i>

Middlemen	investments don't fully arrive at the project developers because middlemen cost up to 90% of the price of carbon credits, and take a share of upfront financing	<i>for instance, it was 60 to 90% of margins to brokers and traders. – W3.9</i>
Demand & Supply	Lack of demand for high-quality carbon credits due to too high risks, reputational risk, lack of trust, no overview on the quality	<i>we're hearing corporate say [...] I can't take on the reputational risk of engaging with this asset class. So I think that's the biggest bottleneck right now is in terms of generating that that demand pressure and getting capital – C2</i> <i>An unwillingness to engage with something that might get a company accused of greenwashing – C2</i>
	Lack of supply for high-quality carbon credits due to project developers not scaling up	<i>I can't stress enough how many clients [for carbon credits] they are like, it's it's truly overwhelming. There's not that many project developers in the world. So finding one [project developer] that is trustworthy [is difficult] – T3</i>
Lack of Commodification	Carbon credits are not standardised enough, and thus not commodified and thus hard to trade and not attractive to invest in with the aim to trade them	<i>my vision for the entire market is that we get carbon credits to a level where we can also integrate it in the same way as in the classic commodity markets, such as oil, for example, where you cannot compare the underlying exactly, oil is very homogeneous – C1</i>

Appendix IV: Learnings

Learning process	Description	Citation
Amongst Project Developers	<p>Little learnings happening amongst project developers</p> <p>Situation</p> <p>They often work with very labour intensive, manual, costly and slow approaches despite of more efficient approaches would be possible from a technological perspective.</p> <p>Many project developers seem to not have knowledge in scaling their operations. There are two named reasons for that.</p> <ol style="list-style-type: none"> 1. project developers often operate under a “donation paradigm”: they work with philanthropic capital (donations) and not with capital that is expected to give a return on investment, which gives less incentive to be maximally efficient. 	<p><i>We work with them [NGOs] to transition or evolve away from a Donations paradigm Into an Impact product paradigm where they sell a specific impact product which could be monitoring planted and monitored for two years -W3.6</i></p>
	<ol style="list-style-type: none"> 2. project developers are coming from non-business focused backgrounds such as forest management and are not used to integrate technology into their operations, and often do not have the capacity or the idea to research which technologies to use. 	<p><i>For it [the market for project developers] being so new, they use such outdated mechanisms - T3</i></p>
	<p>Due to this, the project developers don’t seem to grow with the demand. As a possible reason for that, interviewees say that there is a lack of expertise of operating in business and investment-driven markets.</p>	<p><i>A lot of the people they have in their companies come from a forestry engineering backgrounds, which is amazing, but then they lack the knowledge of what the voluntary carbon market is. So there's a lot of learning that has to be done internally - T3</i></p>
	<p>Some technology companies involved in Project Development are pushing for technological & systemic progress though.</p>	<p><i>We are advocating for radical price transparency on the impact itself, so that we can build more trust in the underlying assets. – W3.6</i></p>
Learning Process amongst Technology Builders	<p>Many different learnings happened over the past years, still a lot of ongoing & future learnings</p> <p>The narrative about how blockchain will influence the VCM & NBS changed over the</p>	<p><i>the whole narrative at the beginning was really about transparency, fragmentation of market, opacity of market. [...] And</i></p>

	<p>years, which can be interpreted as functioning learning processes.</p>	<p><i>then starting from that, then people started to look at, hey, actually, there are other problems, traceability, so the digital MRV topic is something that grew a lot last year. – W3.5</i></p>
	<p>The working groups discussed in the experiment process and social network building led to pilot projects & successful follow-up working groups, which can be interpreted as an intact learning process.</p>	<p><i>We've seen the digital MRV working group from Verra concluded in a partnership between Verra and Pachama to start piloting new digital MRV solutions. [...] there are actual outcomes from these groups from the World Economic Forum as well. [...] they're putting out thought leadership and knowledge - C2</i></p>
<p>Learning Process amongst Technology Developers: Searching a business model though</p>	<p>A learning that needs to happen. Many technology builders in the ReFi space seem to be convinced by the technology and eager to apply it for regeneration and are searching for a business model.</p>	<p><i>many are actually still looking for a business model – W3.3</i></p>
	<p>The required elaboration of a business model changed over time in the ReFi space. Business models started with tokenising any carbon credits, until Verra prohibited tokenisation of verra-certified carbon credits. Now, there is more companies offering bridges and the market is assumed to develop itself further.</p>	<p><i>So the business model was just simple at the beginning, I think everyone said, yes, [...] then of course Verra first hit a lever a block and said, no, not like that. So Toukan, Flowcarbon and all the others were dead. But for the moment they learned to survive, obviously. That is step 1. step 2, is now just now, is just one pressed ahead with Biocarbon Registry and now also Puro, which just offer the bridge. This is now putting Verra and Verra and Goldstandard under pressure again to do something. So that is developing – W3.3</i></p>
<p>Learning around the reputational risk</p>	<p>Learning that needs to happen</p> <p>How to deal with the reputational risk for carbon credit buyers is an often-discussed topic. Many buyers seem to be held-back because of being distrustful in the quality of carbon credits and wanting to avoid the reputational risk associated with being involved in faulty carbon credit projects.</p> <p>To tackle this, dMRV, insurance solutions and more transparent impact tracking are explored.</p>	<p><i>I just wonder whether companies who are interested in buying carbon credits and using them will tend towards projects that are very easy to measure and quantify and monitor, just because they're so frightened of the risks to their reputation on the road, later, perhaps after they've purchased them a year later. And so, either the credits or the, or the trees have</i></p>

A guess on why dMRV is not deployed by many companies is that established companies that traditionally work with audits and not with dMRV are repelled by the increased transparency and accountability that comes along with dMRV.

all burned down because of a forest fire, or the methodology is called into question. And the quality of the credits is now considered to be very poor.- W3.4

I think a lot of companies who would maybe have bought offsets are going to be waiting to see Is it is it a risk of the reputation now to do that, or, you know, there are other ways to do it or what so, - W3.4

we're even seeing corporates who are, you know, not necessarily interested in working through third parties who are starting to think well, should we be our own project developer? Should we take this risk in house? Maybe we'll have more oversight over it? - C2

I would say some, some problems have clearly been persistent. [...] my perception is that there's a consensus on how blockchain can help to solve the issue of double counting. And I think that's quite widely understood in the sector. – C2

I think that's a really important part of the value chain that can aid in risk mitigation, and really quality assurance in carbon assets. And that what what you're buying what you're purchasing, what you're investing in, really is doing what it claims to do. I think digital MRV has a huge role to play there. And so we're seeing a lot of new innovations in that space as well, from air monitoring to soil sensors, ocean acidification, even how to engage communities on the ground and how to track benefit sharing. So when you talk about NBS, I think an area of a lot of interest is showing more transparency, when when a carbon asset is issued, how much of that value is getting

		<p><i>passed back to the community? And especially in terms of monitoring - C2</i></p>
<p>Learning about the relevance & technology – traceability on chain, quality control on chain</p>	<p>Learning is seen happening with having traceability on chain, engaging sovereign local communities, decolonialisation practices,</p>	<p><i>the more and more I meet other people, I think there's a lot of people in the global south where like, we need this to be on chain, we don't need the marketplace, but we need the actual like traceability, you know, in the same way we did with with coffee - W3.8</i></p>
	<p>On the side of using blockchain technology, some interviewees stress that there is a lack of understanding on how the technology can be used, how tokenomics can work and should be elaborated and how to set up a liquidity strategy. It seems that these things were not relevant for raising VC investments in the past hype around tokenisation. The use of tokenisation seems to be not always well understood, some interviewees state that tokenisation alone does not solve problems but that it should be well-embedded in a larger system.</p>	<p><i>I've met entrepreneurs in this space, who were like, grown man who apparently went to Harvard or this university or that and I'm like, Well, what's your liquidity strategy to make sure the value of the token doesn't go to zero? They're like, What do you mean liquidity? And you're like, how am I gonna explain it to these guys? Like, it's so hard? And there's that whole like, you know, there's the whole issue of like, oh, like, I'm a white guy with the tech startup - I2</i></p>
	<p>However, others are stressing that using the technology for dMRV and tracking the value chain and the quality of carbon credits is a learning that the niche collectively is making, and there are working groups emerging around these topics and startups founded tackling them.</p>	<p><i>W3.8, T2</i></p>
<p>Learning on how to deal with hq carbon credit scarcity</p>	<p>With this expectation that the quality of carbon credits matters to the buyers, there is a shortage of high-quality carbon credits that have their quality transparently traced.</p>	<p><i>You need a grip on the projects. Because that's going to be the scarcity. – W3.3</i></p>
	<p>With this shortage, some companies start to vertically integrate the supply chain of carbon credits and become project developers themselves. Others pivot towards helping project developers to more reliably deliver high-quality carbon credits and to proof the quality digitally.</p>	<p><i>Sure, we'll have a supply issue. But that's a good problem to have, then we can channel a bunch of capital into new projects and bring them online and have the market be working more effectively. But getting that demand in the door, I think is the first big barrier and</i></p>

*bottleneck to overcome to really
unleash the scale of potential - C2*

Interviewees agree on that this
development goes into the right direction.

Learning around local
communities

Learnings around how to engage with the
local communities seem to be slow, but that
may be inherent to the matter of the topic,
as it takes time to build trust, and altering
community processes should not be fast-
tracked but should be designed mindfully.
Some startups in that area focus specifically
on how to engage with the land stewards
and how to reward them in a just way,
sometimes with minimising the interaction
with middlemen and with a focus on
keeping their social web intact, whereas
other entities do not consider such
questions.

*the aspect of decolonization that
I've never found in any other web
three organization or opinion, the
element of being or working
bioregionally of not importing a
solution or working with sovereign
communities that have never been
working with it and ever before, the
criteria that regen Foundation
works with is something I'm really
excited about. – W3.8*

Often, colonialist practices are replicated
with setting up caron credit issuing NBS
projects and this is critically observed by
many interviewees.

*So these people still own 180,000
acres of land in a place where they
can set up a five star hotel and get
tourists and not pay tax because
it's a conservancy. And they set up
a trust, because they want to take
care of the community, the
community who are their
employees, by the way, and they
set up a trust and they use the
pictures of these employees,
families, to say we want to help
these people. And they go and they
get the grants, they go get the
green grants, they get the green
funding. To take care of the land,
they already have their ID Oh,
which has five star hotels on it. Like
it's ridiculous. And no one's talking
about it. And these Maasai the
people on the ground, they have no
idea about the justice they deserve.
They have no idea about the actual
billions of climate financing that
exists. And they do this, they do the
work that they're continuously
doing for free.- W3.8*

Engaging with local communities can bring a lot of complexity with it, and sometimes good-intentioned actions lead to bad outcomes.

you thought, oh ok, and then the people who pay the reforestation those were also really decent wages, fair wages that are also above the minimum wage, sounds nice at first. And at some point we realized that the people in the village could no longer afford the food prices in the supermarket, because some people in the village now had much more money than others, and then the prices in the local grocery stores rose, so that the population that did not work in this reforestation project, so to speak, no longer had enough money. So there are just so many complex steps that are extremely important. – T2

Still, carbon credits and the revenues from them are seen as the best scalable mechanism to actually reward the land stewards for their work.

And we came to the same conclusion that although carbon credits are by no means perfect, they're one of the few scalable financing mechanisms we have to reward land stewards for doing good things for the planet. And that is what we need - T1

Some remark that the type of funding for local communities is different than the type of funding for a tech startup, and that the funding for local communities needs to have room to discover and iterate and experiment more, and that the payback process is slower.

VC is one type of funding, right? It's yeah. And it's focused on growth at all costs. That is the that is the point of venture capital. And that's what it's really good at unleashing. It's not right for everyone at every stage. So maybe we think about different financial structures that can enable more discovery and iteration. In those really tricky areas, like governance and social interaction at the community level, you may need different forms of capital, like grants or more patient capital that that can evolve. And is really accepts the risk of of being lost. Because there's going to, I think, I don't know sometimes grants are an underappreciated type of capital, because they aren't necessarily tied to outcomes. But sometimes you can't guarantee an outcome. That's what learning is,

right? And when a market is so early stage, that's really critical. You need to learn a lot. - C2

Learning around collaborating with the regime / reach the market

Some stress that the ReFi space has not learned that it may be alienating to the regime to communicate and operate in a rather utopian manner:

Also, with a kind of attitude of, well, everything in the web two world is broken and shit, we will make it better. And I think if you do that, you just alienate a whole bunch of people who actually you should be bringing on board and not alienating utopian political visions of complete decentralization, and we can just do better than the people who went before without their support. And without their integration. I think that's utopia. And I think that's a certain degree of naivety of people who've not really had much experience of, of trying to scale something in the real world - W3.4

and some even go so far to state that the majority of ReFi players does not have the intention to reach the market.

they don't work with anyone outside of ReFi - (W3.9)

While other technology builders pivoted away from being in web3 with the reasoning that possibilities to scale investments into NBS are larger in traditional markets, reasoning that traditional banking has efficient markets and the financial power and potential impact.

And then it turns out that, no, the market actually has to move in the direction of traditional banking, not that we are the biggest advocates of the banking culture. But there is simply an infrastructure behind it that ensures that the whole thing works and that the markets are reasonably efficient. Yes, we have noticed that. – W3.3

Especially some hedging solutions are seen to be needed to increase the trustworthiness and decrease the reputational risk, and for that some people stress that traditional financial and insurance solutions are needed.

So I don't see the solutions in the Web3 area now, rather, as I said, hedging solutions are needed, traditional financial solutions and insurance solutions are needed. – W3.3.

Appendix V: elements that hinder scaling / that are missing to scale

Missing element for scaling up	Explanation	Citation
No intention to work with the market	<p>Some interviewers state that they do not see an intention to reach the regime or a bigger market amongst ReFi companies. This is framed to be rooted in ReFi not wanting to collaborate with the established system. The underlying mental model to that is that the established system is perceived as faulty and broken and needs to be replaced completely. This in some cases results in that ReFi companies do not want to certify their credits with the market-leading certification offers, and do not want to sell their credits to the main market.</p> <p>This idealism is pointed out by many as a barrier to scaling the market – the technology itself has usecases where it makes a lot of sense to use the technology, but it is not a silver bullet.</p>	<p><i>Well, Refi has a main problem, and that they don't work with anybody. They don't want to certify their credits. They don't want to sell to main market. It's like I tell everybody, like, are you going to sell your carbon credit and refi to a naive consumer? Who knows nothing about the markets, that's a Ponzi scheme? Are you going to sell it to a regulated buyer like Shawn Chevron to offset their emissions? Because that would be like in the marketplace, the majority of Refi has no intention of actually reaching a market. - W3.9</i></p>
Standards pushing back	<p>In terms of collaboration with the regime and the certifiers, some certifying standards pushed back against using tokenisation with carbon credits, which was rooted in that some players tokenised retired credits. Standards state that they paused to allow tokenising existing carbon credits to avoid double counting and to ensure continuous impact and quality.</p> <p>However, some standards have now set up working groups to explore the potential of tokenisation and dMRV, as elaborated in the section on learning processes.</p>	<p><i>So you had a huge rush in the web three space towards carbon credits a year and a half ago, two years ago, and gold standard in other standards prohibited around this time, last year, we prohibited the tokenization of credits. So we said you can't you can't bring our trad credits on chain. And the main reason for that was it was being done in a way that wasn't, wasn't really integrated into the registry. So credits would be retired on the registry. And retirement normally means the credit is out of circulation, it's been used towards the target, but they would retire them and then give them a second life on chain. And that means it's not possible for us to really check and understand what's going on with credits in a way that's expected of us. And so that was the reason why we prohibited it. – S1</i></p>

Then you realize, okay, credits, then of course Verra first hit a lever a block and said, no, not like that. So Toukan, Flowcarbon and all the others were dead. But for the moment they learned to survive, obviously. That is step 1. step 2, is now just now, is just one Vorgeprescht with Biocarbon Registry and now also Puro, which just offer the bridge. This is now putting Verra and Verra and Goldstandard under pressure again to do something. So that is developing – W3.3

So I think what we've learned in that time, is there was a lot of interest and hype around tokenization itself. But obviously, this caused a lot of backlash, and pausing from traditional players in the market. So you're probably familiar with, around May of last year, May of 2022, Verra issued a pause on the tokenization of its carbon assets and said, Hey, this is not permitted, just because we don't know what all of the impacts will be. And we don't want to enable this, this evolution to take place just yet until we have a firmer understanding of all of the repercussions, which I think is a fair stance to take, needing to pause and assess what's going on before moving forward with this digital transformation.- C2

Others frame the pushback of standards less as rooted in not wanting to create negative impact, but in not wanting to be outperformed.

So the refi and blockchain is wonderful for financing projects. So early financing, because you can also many because it is otherwise very difficult in the old legal system. [...] The problem is simply, just unfortunately with tokenomics, that these old regulations often crush it, that they say, no, we don't want anyone to make it better first - W3.2

No interest in refi from non-refi people

The market itself is perceived as rather small (with a volume of usd 2 billion) and not able to shift things with that size.

In the way we scale this market further to a size where it can really make a difference, which is actually

the basis of the whole market, but for which it is currently far too small. In Voluntary Carbon Markets 2021, it was around two billion. - C1

Some state that there is little interest in tokenised carbon credits from companies that do not have other touchpoints with Web3 out of being convinced of the technology and decentralisation. It was observed that large players are not even pushing back against the market but ridicule it as irrelevant.

Its not even pushing back? It's like straight up ridicule, which is not unusual for emerging technology. It's also unwise to ignore technology, as everybody knows. So there's there's a very happy medium between writing it off as adolescent. And realizing that it's too young to be a real threat. - W3.9

Many players outside of the niche do not have any touchpoints of the technology, and often perceive blockchain-related projects as opaque and are irritated by the niche-specific terms and names. And at the same time, the niche itself is seen as too idealistic and naïve, and does not understand that it has to collaborate with non-web3 companies to create an impact and to scale, and that purely replacing the system is utopian.

one of my biggest concerns is that when we're in the web three space, and we're talking to other people in the space and other people in the defi space, it all sounds really good. They all sounds like Well, yeah, this is utopia. And we can make all this work and make all this happen. And then you go and talk to somebody outside of the space and they go, and what blockchain bullshit, what's this? It's a long bridge, to get to those people who don't understand this world. And, in fact, they're quite resistant to it. They're like, I've got A what now I don't understand what you're talking about is nonsense. And I think it will succeed to fund NBS at scale, if the solutions can be made in a way that can reach out to people who are not inside the bubble. Because I think for me, 90% of the projects that I see and the communication around the projects and the mechanisms, those projects that use something called tokenomics, all of these projects that are doing this kind of activity, are very, very opaque for people who are not into the scene, they don't understand what's going on. So that's really important that actually is made to bridge the outside world. And one of my concerns is that a lot of the projects are really taking a very much a defi approach. Also, with a kind of attitude of, well, everything

		<p><i>in the web tool world is broken and shit, we will make it better. And I think if you do that, you just alienate a whole bunch of people who actually you should be bringing on board and not alienating utopian political visions of complete decentralization, and we can just do better than the people who went before without their support. And without their integration. I think that's utopia. And I think that's a certain degree of naivety of people who've not really had much experience of, of trying to scale something in the real world. - W3.4</i></p>
	<p>Others remark that large public companies have little reasons to do business with small startups, when their services are far in the future and they do not have a proven track record yet.</p>	<p><i>anyway, we are in start-up, which is just somehow exists for 1.5 years. Why should we... Why should a Dax company transfer money to us, yes? I had to ask that question and then I had to create a structure that makes it easy for them to interact with you. So to set up traditional settlement and companies and things, to set up infrastructure, for example. - W3.3</i></p>
<p>Project developers working in donation</p>	<p>As reasons for project developers not having access to more working capital, there are different reasons named: the one is that the investment structure is not very attractive in terms of return on investment, and the other one is that project developers often are used to work with donated or philanthropic capital, which is not expected to be paid back or to create a return on investment. The shift toward working in an investment-based mindset and away from a donation-based mindset is named multiple times as a necessity to get more investments for NBS projects. This, however has little to do with the blockchain technology.</p>	<p><i>W3.6, Others – also, mentioned earlier already</i></p>
<p>Project developers not managing to scale</p>		
<p>Lack of trust, lack of understanding</p>	<p>Reasons for little interaction between customers and the niche are three-fold. The one reason is that there is a lack of trust towards tokenised carbon credits, which is connected to both the shady image that</p>	

	<p>web3 technology has, and to the past tokenisation of low-quality and already retired carbon credits. Thus, companies do not want to expose themselves to a potential reputational risk, and they do not want to spend money that is meant to create impact on initiatives that promise to do but don't.</p>	
	<p>The second reason is that it is already a voluntary step that relates to effort for customers to compensate their carbon emissions, and there is often no need seen to go one step further.</p>	
	<p>The third reason is that within the tokenised carbon credit space, many players try to frame themselves as the best alternative to the established market and the contradicting information on which initiative and which product within the niche is the best might confuse or repel potential customers.</p>	<p><i>there you talk maybe only with 2 people and buy everything from both that is yes very critical that is with 10 and afterwards one is confused and there he is anyway again he has only a little budget but as soon as that changes then you want to quickly crystallize out - W3.2</i></p>
<p>Not tackling the needed problems</p>	<p>Another thing that is seen as more important than marketplaces are other technological solutions such as so called oracles, the digital infrastructure to connect smart contracts with events or systems outside of a blockchain ecosystem.</p>	<p><i>I think it is hard to do, because it requires you to build Oracle's with hundreds of payment gateways, which is very complex.- W3.6</i></p>
<p>Investments don't arrive at the ground</p>	<p>Another criticism is that investments should also help the land stewards in the global south to profit, and not only be good for startups in the global north again.</p>	<p><i>you need money on the ground to stabilize the projects and to actually finance this nature conservation and at the same time, however, actually again a money machine is created, which efficiently pumps money from the global south, yes, into any start-ups to Europe or to the USA. – T2</i></p>
<p>Not tackling the actual but the easy problems</p>	<p>Some people criticise that there are many marketplaces and many brokerage services, but that they do not actually tackle the project origination shortage and the high-quality carbon credit creation shortage. According to the data, the niche should work on (technological) solutions to the learnings that are happening or should happen, and not try to launch "yet another NBS carbon credit marketplace on chain". The assumption is that in the end, there will be only a few dominant marketplaces, but other problems like insurance solutions or</p>	<p><i>there are more marketplaces than there are actual projects, and there actually needs to be a lot more good projects, and of course that depends again on how they are implemented. – T2</i></p>

dMRV solutions should be well-developed and scalable as well.

Instead, more projects should be developed, and the process around developing a project & getting investments for it and revenue from it should be improved.

the real critical bottleneck is how do we develop credible projects, where do we develop credit? And how are we monitoring that over time and in a similar way that when we were having these discussions with, with the bank here, and we were really pushing on the fact that the critical juncture is not in creating a new marketplace. It's in creating facilities, or investment. Right. And then if you do that, then of course, you can eventually go and sell them and you might want to create a marketplace, but the focus should be 90% on on the investment side and 10% in the marketplace.- W3.6

However, the roots of this problem are painted in that it is more interesting for VCs to invest into marketplaces and not interesting to invest into more origination-related companies, because the latter seems to be harder to scale.

I compare the origination business a bit with an Amazon market, so a VC understands that I sell fish food on Amazon. And when you say, well, I still have to cut the fish food into small pieces and pack it into cans, then the VC is usually already out. Because it's just not that scalable, just the problem is, you have up front there, and that's also kind of a curse and a blessing, I think, and also make or break it for a lot of the web three companies. You need to have a grip on the.... on the projects. Because that's going to be the scarcity. - W3.3

Appendix VI: Informed consent form



Utrecht University

INFORMED CONSENT FORM for participation in:

<Please enter title of your thesis>

To be completed by the participant:

I confirm that:

- I am satisfied with the received information about the research;
- I have been given opportunity to ask questions about the research and that any questions that have been risen have been answered satisfactorily;
- I had the opportunity to think carefully about participating in the study;
- I will give an honest answer to the questions asked.

I agree that:

- the data to be collected will be obtained and stored for scientific purposes;
- the collected, completely anonymous, research data can be shared and re-used by scientists to answer other research questions;
- video and/or audio recordings may also be used for scientific purposes.

I understand that:

- I have the right to withdraw my consent to use the data;
- I have the right to see the research report afterwards.

Name of participant: _____

Signature: _____ Date, place: ___/___/___, _____