Salvage Technoscience:

Conserving and Extracting the Value of the Amazon Rainforest

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1. Introduction

Forests occupy a special place in the cultural imagination of Western thought, not the least for their perceived role in the ecological dilemmas that have been haunting humankind throughout periods of modernity (Harrison, 1992). "Forests" are of course many things, and each particular forest may give rise to individual projections of ideals, images or conflicts related to ecological dilemmas just as different cultures or sociotechnical infrastructures may see forests in specific ways (e.g. Gabrys, 2020). In this article, we discuss the particular space occupied by the Amazon in the technoscientific imaginations of Brazilian biologists and tech industry, and how their relations to the Amazon are orchestrated by the dual concern of conservation versus resource extraction. On the one hand, the Amazon is perceived as a pristine place that needs to be protected in its own right and because of narratives of its value as either a biodiversity hotspot or 'the lungs of the world' (e.g., Davidov, 2013). On the other hand, it is perceived as a site for almost endless (natural) resources that can be exploited or extracted, sustainably or otherwise, for the benefit of a national economy. This dual concern has dominated how the Amazon has been seen and treated historically in Brazil, but it has arguably become even clearer in today's crisis-ridden world, where contemporary technoscientific approaches to the Amazon are dominated by what we refer to as "salvage technoscience". The proponents of these approaches not only claim they can combine the two concerns of protection and profit, but that the former relies on the pursuit of the latter.

By "technoscience" we refer to a scientific orientation that gives special importance to the development of technology (Hottois, 1984) and to the role that science has in intervening in so-called real-world problems through the use technological applications (Nordmann, 2011: 26). For this and other reasons, technoscientific approaches to the world are not devoid of ontological, epistemological and political-ethical dimensions (Bensaude Vincent and Loeve, 2018). These dimensions are recognizable in the different initiatives we analyze in this article. As such, the dimensions provide a suitable entry point for studying how technoscientific

initiatives play a role in the capitalist pursuits of forest sustainability and for studying the changing imaginations of forests more generally.

Our coupling of technoscience with the notion of "salvage" contributes to highlighting the ambivalence of the relationship between technoscience and capitalism by merging two meanings. The first meaning relates to how technoscience initiatives we have studied aim to save and conserve entities on the verge of extinction. The second meaning refers to the impulse to take that which they want to conserve and include it into a capitalist mode of production, circulation, and consumption. The former meaning is aligned with – for example – the intentions behind the initiatives of salvage anthropology of the past, which were aimed at preserving disappearing cultures (e.g. Redman, 2021). The latter meaning builds upon the discussion of what Anna Tsing refers to as salvage accumulation – a reference to the modes of extraction that appear in the margins of the contemporary capitalist system (2015).

We argue that contemporary "sustainable" solutions for the Amazon extend this ambivalence in relation to the forest through practices and technologies aimed at urgently "salvaging" the rainforest. This is done in the terms of a capitalist economy driven by technoscientific breakthroughs. Legitimized by approaches such as biomimetics or biomimicry[1], and ideals of innovation driven by Silicon Valley-inspired entrepreneurs, salvage technoscience embodies the hope of achieving unlimited digital extraction from limited natural resources, all the while attending to sustainable development goals (see Davidov, 2019). While we show that technoscientific initiatives aimed at striking a balance between conserving or conversely extracting value from the Amazon Rainforest are not new as such, we contend that the term salvage technoscience captures the ambiguities of recent tech-driven initiatives, where conservation is enabled through business. The two meanings of salvage capture the sometimes-well-intentioned efforts of preservation or conservation as they take place through the collection, recording and rearranging of the value of nature's resources, which allows what is collected and recorded to be commodified. Salvage technoscience only regards conservation or preservation of a forest as realistic if it makes the forest's resources available to markets. This accentuates a rhetoric of neoliberal capitalism, which portrays every initiative as not just "win-win" but as providing "multiple wins", where everyone – including corporate investors,

[1] The term biomimetics was coined by biophysicist Otto Schmitt to designate the study of the formation, structure or functions of biological processes or substance, and the transfer or emulation of ideas and analogues from biology to technology (Vincent et al., 2006: 471). Biomimicry is a more recent design-based approach stemming from biomimetics (see Fadok 2021). We return to these approaches in a later section.

biodiversity, scientists, different tiers of government, and indigenous people – is assumed to benefit (Igoe and Brockington, 2007: 435).

In this article, we first outline in further detail the dimensions characterizing technoscience and the dual meaning of the notion of salvage, then we present a Brazilian scientist-driven initiative named Amazônia 4.0 that aims to implement a what it claims to be a new sustainable development project for the Amazon region. Lastly, we put the Amazônia 4.0 initiative into perspective with reference to a) historical forms of Amazonian conservation and extraction, and b) a contemporary Brazilian blockchain initiative named Moss.Earth. What is new about these initiatives is the type of 'object' or 'value' they aim to extract from the forest, and how the extraction is enabled by technological advancements. The fact that the initiatives we have studied are still at early stages of project development makes it difficult to assess their social and economic impacts "on the ground". Therefore, we analyse them in relation to what they aim to achieve, mostly highlighting the ways in which they rhetorically connect economic ideals with ecological concerns. Hence, our intention is not to evaluate the practical effects of the approaches in question, but to locate them within the historical and ideological context of technoscientific and capitalist expansion into the Amazon Forest.

2. Dimensions of technoscience

Philosophers of science and science and technology studies scholars have long discussed the meaning and relevance of the term technoscience (e.g. Hottois, 1979, 1984; Latour, 1987; Channel, 2017). In order to frame the initiatives that we analyse, we follow the lead of authors who refer to technoscience as a field of practices with distinct characteristics (e.g. Nordmann, 2011; Bensaude Vincent and Loeve, 2018). Some have, for example, tended to define technoscience as the technological and social contexts of the conduct of science. We choose rather to point to the enmeshing of science as the knowledge practices interested in understanding the laws and facts of nature, and technology as the practical development of techniques and objects (e.g. Channel, 2017). As a conjunction of the words science and technology, technoscience denotes in this perspective a blurring of the boundaries that conventionally are seen as separating the two (Channel, 2017: 1-22). This blurring has become particularly manifest with the emergence of fields such as biotechnology and scientific production geared towards – and funded by – markets, where there has been a burgeoning space for entrepreneurs deploying science and technology for capitalist purposes of making profit (see Carrier and Nordmann 2010; Birch 2020).

Consequently we take from Bensaude Vincent and Loeve (2018) a focus on the ideals embedded in technoscience, which they contrast to science through three dimensions: ontological, epistemological, and political-ethical. *Ontologically*, objects – such as cells, neurons or molecules – are in technoscience not considered "at a distance" as they are by the scientist who tries to understand them and the laws that guide them. Rather, objects are in technoscience considered for their dispositions and for what they can do. The scientist manipulates objects or reverse engineers their potential for specific ends (idem: 176-178). *Epistemologically*, technoscience research is more interested in designing or repurposing than in understanding natural laws by hypothesis testing (e.g. synthetic biology). Technoscience thus ends up highlighting nature itself as a potent designer, trying to use nature itself as a springboard for invention or for reengineering. It is in the context that practices such as for example biomimetics emerge (idem: 172-174). *Politically and ethically*, it is integral to the agenda of technoscience that its production is guided by values – economic or ethical – which is a "shift from the modernist self-image of science as value neutral" (idem: 178). These three dimensions all apply to the initiatives that we analyse. The importance, for example, of producing science with both an economic and ethical purpose, such as saving the Amazon Rainforest, is at the centre of both Amazônia 4.0 and Moss.Earth. Their main purpose is to pursue disruptive, scientifically based models of economic development enabled by technological applications that can ultimately reveal how the forest has economic value worth protecting and extracting.

3. Meanings of salvage – from colonial to technoscientific capitalism

Producing science and technology with economic and political-ethical purposes in mind can be fraught with social difficulties. Today the economic system of capitalism is itself becoming increasingly organized or configured through digital technologies and technoscience more generally (e.g. Suarez-Villa, 2009; Birch, 2020). For this reason, we find it important to reiterate how the production of value for markets is not solely conducted by the technoscientific advancements in the centers of the global economy through new forms of rentiership and "assetization" of and through data (Birch and Muniesa, 2020). As shown by Tsing (2015) and others, capitalism still relies upon "salvaging" relations to the margins no matter whether these relations are dominated by extraction or conservation. This extraction is, however, no longer only of physical objects. It is increasingly entangled with intangible and often datafied resources subject to intellectual property rights.

It is to highlight this complexity that we refer to the concept of salvage. It has a long and important history in anthropology, where it exemplifies the ideological, moral, and political dilemmas involved in doing (social) science for the sake of preserving past or present conditions of life. Although predominantly tied up with the colonial legacy of anthropology, referring to this tradition highlights many of the dilemmas present in contemporary technoscientific approaches to the Amazon. The most basic parallel is that "If change was to be the inevitable price of human progress, some thinkers wondered if this toll might be diminished by preserving elements of the threatened cultures on the road to extinction." (Redman, 2021: 2). Samuel Redman (2021) has discussed how salvage anthropology was an at times massive scientific project driven by the urge and the felt need to conserve, to protect and to rescue something (tangible or intangible) before it was gone forever. It was carried out by stabilising an object (for example the cultural heritage of "primitive peoples") against the backdrop of rapid (capitalist) change from which this object was compartmentalised. Salvage anthropology relied on paternalistic, colonial or imperial attitudes towards that which had to be salvaged, and especially towards those from (or for) whom things had to be salvaged. It was not about rescuing human lives as individual persons with emotions, feelings, longings – sometimes for giving up the old lifestyles – but about rescuing that which they possessed; the capacities or properties seen as "exotic" by the salvaging agent.

There is, nonetheless, a second meaning of salvage, which the work of Tsing (2015) has made salient in anthropology and related disciplines. Tsing uses the gathering, trading, and consumption of matsutake mushrooms to explore larger political, economic, and social questions that characterize contemporary capitalism. Capitalist production, she argues, not only takes place under capitalist control. Even the resources that are essential to factory work are extracted from enclosures or habitats outside capitalism (e.g., from commons). Her use of the term "salvage accumulation" characterizes these processes of inclusion into capitalist supply chains and at the same time hints at the historical relationship between colonialism and capitalism. This use of the term salvage here helps see nature or the environment as sources of accumulation, even identifying value in environments that have been broken or degraded from previous "original" or "pristine" states.

The combination of the two concepts salvage and technoscience allows us to emphasize how technoscience is both involved in interventions into the natural world and designs of nature, and how it is implicated in the social relationships and the political-ethical issues of how to balance or combine conservation and extraction. It is for these reasons that we propose salvage

technoscience as a concept that can help us focus on the role played by the joint efforts and expertise of the biosciences and the tech industry to save the Amazon through approaches that combine conservation with the possibility of exploiting and extracting resources from the forest. Our argument here resembles analyses of "neoliberal conservation" with its focus on placing conservation policies in a broader context of the social and economic changes. These entail the commodification of natural resources and a reterritorialization of land driven partly by new types of partnerships between states, NGOs and private corporations (Igoe and Brockington, 2007, see also MacDonald, 2008). Our argument also resembles that of Alice Kelly (2011), who has demonstrated how conservation can be configured as primitive accumulation, as much as we speak to the broader debate about "green grabbing" (e.g. Fairhead et al, 2012). We add to these discussions by arguing that technoscience is involved in expanding the capitalist processes of conservation beyond the protection of forests that turns them into enclosures. Salvage technoscience potentially reconfigures the forest ontologically and epistemologically. This is an implication of the identification of new bioscience commodities, and the extraction of these and other values from forest lifeforms, taking place in parallel to – and as a condition for – the efforts of conservation.

4. Deploying technoscience to salvage the Amazon

Our attention to the different ways of seeing the Amazon through the lens of "salvage" was sparked by an initiative spearheaded by Carlos Nobre, a well-known Brazilian climate scientist. Named "Amazônia 4.0", the initiative aims at deploying technologies of the fourth industrial revolution[2] (hence the 4.0) to develop a "third way" of land use in the Amazon. The proposed third way model of land use (and the contrasting two ways that came prior) are described in a foundational article by Nobre and his brother (Nobre and Nobre, 2018). They describe the first way of land use as defined by the spread of officially protected areas and the second way as one based on intensive resource exploitation (idem: 185). The first way would not take into consideration the need to economically develop the Amazon region, which they argue would benefit its populations, whereas the second way achieved national economic development for a minority through forest destruction. The "third way" proposed by Amazônia 4.0 would, in contrast to the previous two, be anchored in an innovative and knowledge-based bioeconomy that is meant to generate value from the forest while at the same time leaving it standing.

[2] A term used as a characterization of the contemporary rapid technological development which has been popularized by World Economic Forum founder Klaus Schwab among others (2016).

Our original intention was to work ethnographically with Amazônia 4.0 and other salvage technoscience initiatives, but we quickly learned that conservation was a contentious issue in Brazil under Jair Bolsonaro,[3] and in addition the COVID-19 pandemic meant that much of our data collection came to rely upon information from online sources. These included interviews conducted via Skype, Zoom or MS Teams, and participant observation at online workshops or webinars held via Zoom rather than attending meetings and workshops physically. Some – but not all – of these webinars were recorded and are accessible on the websites of the organizations in question. On top of that, there is much publicly available information especially about the Amazônia 4.0 initiative, which has been promoted both through their own publications but also through media attention. To further contextualize the contemporary initiatives, we also traced some of the implicit historical references made by the technoscientific actors in question. This was both to appreciate (or be critical of) the claims to novelty of their approaches, but also to understand the trajectories of the different ideas of the forest that was informing their perspectives. These perspectives included ideas of what threatened the forest (or Brazil as a nation), of what was causing the need for urgency implied in salvage approaches, and why the Amazon Forest was regarded as so valuable in the first place (and for what and to whom). Paying attention to historical perspectives, which we will return to below, has also allowed us to appreciate how ideas of salvage have been embedded in various historical technoscientific ideals related to the different values of the forest either *as* forest or as something it somehow "contained" (timber, farmland, genetic information, biodiversity etc.).

Going more in depth with the Amazônia 4.0 initiative, we learned that their approach on the ground is aimed at making mobile labs and training facilities that will work as "mini-factories in the heart of the forest to transform bio-raw material into higher-value added products" (Rio Times, 2021). This would generate money for the Amazonian communities in which they are installed. These mini-factories are also called "Creative Labs" and consist of a dome-shaped structure containing all the machinery necessary to process local Amazonian products. The cacao Creative Lab, for instance, will house everything needed to turn cacao into chocolate from basic machines such as the melanger, to automated cocoa fermenter and chocolate 3D printers. Whenever possible, the equipment will be monitored remotely and communication between them happen through IoT systems. The Labs are imagined with a design that makes them as sustainable as possible by using renewable energy and waste treatment. The

[3] Consequently, we deliberately keep the names of some actors anonymous in order to protect them in what some of them consider a tense and conflictual atmosphere with high stakes.

communities in which the Labs are installed will learn how to handle the machinery and take ownership over the entire process.

When it comes to the conservation model establish by Amazônia 4.0's plans, the initiative does not engage in forest protection as such, or specifically punish activities regarded as threats to the forest (e.g., cattle ranching, mining or agricultural monocropping). Instead, it is aimed at providing incentives by ensuring that local producers of crops such as cacao or açaí will get better prices through a process of production, manufacturing and transportation supported by big data processing, automation and artificial intelligence, and drones. It is a vision of sustainability according to which communities if given better economic conditions are more likely to protect their source of income – an income which relies on the economic valuation of the forest. This economic value in turn becomes the only way of shielding the forest against destruction (Holmes and Cavanagh, 2016: 204). Central to this model of conservation and development is a (neoliberal) belief in rational and maximising individuals[4] as well as a trust in technological developments such as those associated with the fourth industrial revolution. An example is the use of biomimetics to design new applications that can tap into hidden natural assets, functions and processes (unique molecules, genes, metabolisms) to be used for new pharmaceuticals, cosmetics or food products.

Amazônia 4.0 is not the only such initiative (see Goering and Teixeira, 2023). Others have likewise pursued a conception of the forest as a repository for generating bioscientific knowledge. The following excerpt from an online presentation exemplifies this by addressing how genomics can be exploited to its full potential due to digital technologies:

> "(…) I wanted to talk to you (...) about genomic studies for the conservation of Amazonian biodiversity (...) The reason for these studies, everyone here already knows (...) the issue of climate change and the consequence of these climate changes is the deforestation of the Amazon region. And the loss of biodiversity resulting from this action is very great. What we do not have is time for the actions necessary to know and generate mechanisms to protect this biodiversity and the recovery of already degraded areas. And for this reason, I think we should both use the tools already available and also make use of new tools (…). It's not a reinvention of the wheel, but the massive use of DNA sequencing-

[4] Or "eco-rational subjects" with the "eco" standing for both economic and ecological (Igoe and Brockington 2007: 442).

> based technologies because they put all the knowledge of biodiversity into what I call Biodiversity 4.0. That is, the digitization of our knowledge of biodiversity but in an incisive way, you know? And not only can you look at the history of knowledge online but make digital use of that knowledge" (fieldnotes on online presentation, 2022).[5]

The excerpt firstly addresses the need for urgency, which is an underlying motivation for salvage approaches. This urgency of salvaging what remains of a rapidly disappearing forest underscores the importance of employing technology on a massive scale. The scientist behind the passage works in the Amazon and justifies the importance of collecting environmental DNA (eDNA).[6]. Their goal is to eventually create a comprehensive inventory of the region's flora and publishing the first such inventory for the Amazon biome. During the online seminar, the scientist also listed the many advantages of this method: eDNA is faster and more precise than its human morphologist alternatives. It is thus more appropriate when swift action is necessary, and the codification of species into bar codes eliminates the variability of manufactured entrances by substituting it with a computational entry and enabling the transposition of biodiversity into the digital realm. Here, technoscience is meant to provide speed and standardisation to counter the rapid environmental degradation.

Secondly, the promise that technoscience can help salvaging the Amazon emerges from its important role in helping to identify and recover otherwise invisible potentials and materials from the forest as well as from its role in producing knowledge on both biodiversity and the effects of climate change. The technologies of recovery that would be required are, however, not always described in detail. One can nonetheless get a feeling for their (often unrealized) potential by listening to scientists' presentations. During the launch of a feasibility study for AmIT (the Amazon Institute of Technology), a pan-Amazonian education and research institution aiming to develop technologies for advancing a bioeconomy of the forest and its inhabitants, the presenter noted:

> "(…) the Andes start to rise 65 million years ago and gave rise to the Amazonian terrace (…) and exposed to a lot of tectonic activity and climate challenges. The organisms living under such transformation in the Amazon incorporated the adaptative means to

[5] This and other quotes from presentations and videos have been translated from Portuguese by one of the authors.

[6] Environmental DNA (eDNA) is DNA sample collected from an environmental instead of a single individual. It allows scientists to know more about which species live in a certain area and how populations change in that location through time.

> deal with change in their genetic material. So, many of the solutions (…) to the anthropic challenges we are experiencing today are inscribed in this genetic information; and the technologies we know nowadays are capable of revealing this information to us" (fieldnotes on online event, 2022).

In this quote, nature is presented as an entity with accumulated knowledge so far inaccessible to humans, but it can now be reached by mobilizing the appropriate technology. Advanced technology, firstly, mediates between humans and a knowledge-filled yet opaque environment; and, secondly, technology becomes central as it affords new levels of visibility and understanding that can unlock timely solutions. This is, at first glance, not unlike the deployment of satellite or remote sensing for forest monitoring in the belief that these can provide more "objective", exact and real time data about environments, sometimes disregarding how such technologies are also situated points of view (see Gabrys, 2016; Nost and Goldstein, 2022).

Saving, surviving, and salvaging are intertwined in this technoscience perspective. For example, the quote describes the knowledge embedded in nature as particularly useful against the increasing temperature levels of the climate emergency, which is compared to the situation of cells having to survive under unstable tectonic pressure. As far as the relationship between technology and nature goes, nature is seen as a database of information in need of salvaging. The usefulness of the information – to salvage technoscience – is that it can eventually be deployed either to help humankind in times of crisis or to further economic development. In other words, the technological initiatives in question are on the one hand presented as helpful in producing knowledge on biodiversity and the effects of the climate crisis in the Amazon, but on the other hand they simultaneously advance a bioeconomy subsuming nature to capitalist production of value. Historically, some proponents of salvage technoscience have focused on the "object" (i.e., the processes or the creations of nature to be copied) and others on the human "mindset" needed (e.g., the need to relinquish the wish for control of nature, see Fadok, 2021). However, there has been little focus on the technologies needed to elicit and extract the resources in question. This is where the new wave of salvage technoscience differs, which is the question we return to here.

5. Conservation and / or extraction: a brief history

Until this point in the article we have tended to accept Amazônia 4.0's claim that their approach is entirely novel. Yet, this claim of presenting a "third way" can more cynically be seen as a

way of communicating the value of the initiative's disciplinary approaches or a way to narrate its distinct "brand" or "identity" by differentiating it from state and non-state driven initiatives of the recent past. By scrutinising how the Amazon Rainforest has been perceived historically, we can see that other technoscientific as well as political actors have generally attempted to strike a balance between conservation and exploitation throughout the history of modern Brazil. Some have surely stressed one concern over the other, but both concerns have generally been present simultaneously even if there has been shifts in terms of which concern was the most dominating. Rarely has there been periods where it was exclusively a matter of pursuing one or the other. For this reason, the position taken by many of the recent salvage technoscience initiatives do not appear unique, when put into this historical perspective.

As early as the 19th century, when the rubber boom emerged, scientists and entrepreneurs relied on the ecological thinking of Linnaeus in arguing that the appropriate knowledge and use of the forest's resources did not need to be destructive. Instead, it could protect forests, which had become as central to national development (Cribelli, 2016: 84) as to national identity (Pádua, 2002). This paved the way for imaginaries of the Amazon to shift from being seen as an impenetrable "Green Hell" resistant to capitalist (or state) enterprise to a planned, modernist frontier for development (Hecht and Rajão, 2020).

While the successive authoritarian and military governments of the mid-20th century tended to favour the exploitation of the forest, this period also saw trends going in the other direction. During the Estado Novo period (1937-1945), the authoritarian government designed policies and technologies to develop and integrate the forest into the national economy, but they also supported investments in scientific research and technologies such as the establishment of the National Institute of Amazonian Research and extensive expeditions to document Amazonian biodiversity. The assertion of control over the Amazon region (and the concomitant extraction of resources for economic growth) had become a main concern to the military dictatorship (1964-1985) because of fears that foreign powers would try to access the Amazon and its resources. Consequently, the Amazon became subject to surveillance through a variety of security technologies. In order to subject the territory to control and to support resource extraction, the dictatorship continued to build roads and other infrastructures: among them the Trans-Amazonian highway which opened up the interior of the Amazon region to the rest of Brazil, and the Tucurui hydroelectric dam which at the time was one of the largest in the world. Yet some measures of conservation were still allowed to exist as part of the modernist and developmentalist project, and the rise of conservation ideals and research into genetics around

the same time that the military government was in power was responsible for the few interventions preserving the Amazon at the time (Becker, 1990: 89).

The balancing act between conservation and exploitation has not only existed in the enactment of policies. It has also been present in scientific stances toward the forest. As aspirations of protecting, preserving, and exploiting the Amazon have been mobilized in the ways mentioned above, some scientific disciplines and practitioners have gained prominence. Naturalists, botanists, biologists, and engineers have played a special role in Brazilian history due to early understandings that Brazil's "vocation"[7] had to do with its natural resources or with the development of its agricultural potential. The forest has in this way predominantly been approached as a biophysical entity, less so as a social place of human habitation even if an "Indian Protection Service" was founded as early as 1910 (e.g., Langfur, 1999) and social movement struggles resulted in the creation of Extractive Reserves for traditional communities in the late 1990s (e.g., Hall, 2000).

In the 19th century, the scientists that took part in the Society for the Promotion of the National Industry (*Sociedade Auxiliadora*), one of Brazil's main industrial and agricultural societies, where "an emerging class of professionalized engineers and scientists joined forces with progressive planters and merchants to promote economic growth through technological means" (Cribelli, 2016: 15). The scientists of the *Sociedade Auxiliadora* were resolute critics of slash and burn techniques and proposed that the trees in Brazilian forests could benefit the nation if the right types of entrepreneurs were found to "develop their natural productivity toward economically and socially profitable ends" (Cribelli, 2016: 79). Another example is Alberto José Sampaio (1881-1946), a botanist, who in the beginning of the 20th century was an important figure in the institutionalization of measures to protect nature and in promoting of the idea that taking care of the natural world by using advanced techniques and technologies was directly connected to national development (Andrade Franco and Drummond, 2009). Much later, the way in which scientists managed to convince the military government of the importance of conservation in the 1960s and 1970s was by convincing them that the Amazon's biodiversity could be useful for the pharmaceutical industry and for biotechnologies (Foresta, 1992).

[7] From Portuguese "vocação" or suitability, which implies that Brazil`s choice of economic activity is intertwined with its natural characteristics.

If previous authoritarian governments more readily evoked images of the Amazon as a resource to be exploited, governments of the post-democratization period from 1985 onwards have often conversely subscribed to an image of the Amazon as an entity to be preserved, even if without abandoning or outlawing extractive initiatives. This means that the dissonance between exploitation and conservation became more visible when they were recently juxtaposed in the new salvage technoscience approaches we discuss here. At the same time, their relationship may also be more ambiguous with greenwashing practices potentially obscuring the difference in some cases. By the end of the 1980s technologies such as remote sensing and satellite imaging (previously used to check if agriculture and pasture frontiers were being expanded and to deny claims of deforestation) became used as tools to assess and manage forest degradation (see Vurdubakis and Rajão, 2022). Various programmes aimed at reduction of deforestation or forest restoration were put in place along with plans promoting integrated land use, which involved areas destined for conservation, urban development, and sustainable agriculture. Despite the clear traction gained by conservation interests after democratization, the situation has rarely been straightforward. The military dictatorship's stance towards the Amazon as a matter of national security is a stark example of the demonization of the forest (i.e., as a 'Green Hell' and the fear of foreign influence as mentioned above) and the neglect of its inhabitants.[8] The dictatorship's view is today seen as extreme, yet the Brazilian democratic governments have also been haunted by controversies. Deforestation has increased in periods, and social and environmental damage from construction projects, such as the Belo Monte Dam has complicated the picture of whose democratic interests are served by the government, and to what extend it is involved in conservation (e.g. Jaichand and Sampaio, 2013; Klein, 2015).

To summarize this section, there has thus historically been much debate about the balancing of conservation and extraction with views of the Amazon shifting from an emphasis on the pristine to the demonic and back again. The Amazon has always carried potential for its resources, but what these resources 'are', and the means through which they can and must be exploited, is today increasingly dependent upon technoscientific breakthroughs. These breakthroughs open up new frontiers that claim to combine extraction with conservation – even if the combination appears at times to be ambiguous or superficial (see also Nost and Goldstein, 2022). The attempt to combine extraction and conservation is, however, not new when seen in a historical perspective, and current claims to novelty must be evaluated against the backdrop

[8] The military dictatorship feared that foreign powers wanted to annex Amazonian border regions and undermine Brazilian sovereignty by inciting Indigenous separatist movements. Jair Bolsonaro has appeared to be obsessed with this threat according to some commentators (Phillips 2023).

of – especially – previous attempts by Brazilians scientists and activists of reaching a balance between economic use and conservation of the forest.

6. Extracting while conserving: Biomimetics and biomimicry

It is an open question whether Amazônia 4.0 can deliver on its promises[9], or if it will end up stretching the reaches of a "green" capitalist logic even further (see Rojas, 2022; Urzedo and Chatterjee, 2021). What interests us here is how Amazonia 4.0's rhetoric is an instance of the increasing presence and detail of technoscientific initiatives in efforts to salvage. As mentioned, the choice between conservation and extraction is not so clear cut when it comes to specific historical comparisons. However, reflecting on how the initiative positions itself in relation to contemporary mobilizations of technoscientific views of the forest reveals further details. In a public talk hosted by the University of São Paulo, one of the scientist founders of the initiative offers an insightful definition of what the "third way" could look like, and how it relies upon technoscience:

> "What Brazil has that no other country – except tropical ones – has? Biological diversity. (…) What was missing was to develop a model that, at the time, during the 70s, no country thought of developing. (…) A model according to which we could value, through knowledge, Brazil's biggest wealth" (University of São Paulo, 2017).

This in some ways rekindles an old idea: that Brazil's biodiversity can serve as the base for a nationalist development model and that the forest has unimaginable economic potential ready to be realized. But not all is repetition. The scientist claims that in 21st century it is knowledge and not material goods that has the most value, and he asks,

> … what biodiversity has to do with knowledge? Because knowledge of biology, of how species interact and its trillion of possibilities; how nature solved some problems, this knowledge can generate a new economy (University of São Paulo, 2017).

This is a variation of, if not a departure from, an extractivist logic. Instead of depleting the forest through predatory exploitation of (sometimes finite) resources, the idea is to extract and replicate the forest's knowledge, which could then be used without limitation and without harm to the forest's physical integrity. This prospect appears promising and as an absolute scientific

[9] The initiative is still in process of development and implementation and has already undergone changes since this article was drafted in 2023.

and economic gain for Brazil as well as for humanity in general which is set to benefit from further scientific breakthroughs. Yet such extraction of knowledge will likely reinvigorate old debates about the definitions of various forms of intellectual property. Rather than being "pure discovery", science has frequently built upon knowledge already developed by marginal others but with little recognition of for example local stewards and curators of that knowledge or the lifeforms that hold the knowledge, especially when it becomes appropriated by pharmaceutical companies (see Posey and Dutfield, 1996; Coombe, 2000). The salvage technoscience thus ascribes technoscientific progress to the agency and labour of scientists and their technologies. This at times – but not always – implies ignoring how it is often the combination of humans and environments which has enabled the development of the discovered lifeforms (Fausto and Neves, 2018; Silva et al, 2021).[10]

The scientist in question perceives this new knowledge economy to be enabled by technoscientific breakthroughs. One part of his argument refers to advancements in biomimetics and biomimicry, which we will touch upon here. Another part refers to new digital technologies, which we will return to in the next section.

As described above, technoscientific regimes are epistemologically characterized by the intertwining of "knowing and creating" (Bensaude Vincent and Loeve, 2018: 174), and nature tends to be seen not as a distant object in need of understanding but also as a "designer" (idem), an idea that is propagated in biomimetics. The double function of knowing and creating is somewhat replicated in recent developments in biomimicry, a more recent design-based offspring from biomimetics. The use of biomimetics is seen by proponents as allowing for a change from simple exploitation of limited resources to offering the possibility of both tapping into the unlimited reproduction and extraction of knowledge stored in nature (with the subsequent deployment of that knowledge for even further technoscientific developments) and of maintaining existing resources. As emphasized in the talk quoted above, biomimicry will allow for

> "an economy of learning what one can take from a deeper biology, through biotechnology and other technologies (…). It is very important to learn with biology,

[10] Some initiatives try to solve this by deploying distributed ledger technologies, which we return to below.

what biology teaches us? How natural evolution found solutions (…) a field called biomimetics or biomimicry[11].” (University of São Paulo, 2017).

In brief, biomimicry is a design and innovation approach that draws inspiration from nature and recognizes nature as a powerful source of knowledge about the way that a diversity of processes and systems may work more generally. By observing and learning from nature, biomimicry seeks to apply natural principles, strategies, and designs to create solutions in a sustainable and efficient manner (see Fadok 2021). This form of salvage – urgent because unique natural systems and processes may disappear due to deforestation – relies upon technoscience but also reproduces it.

Biomimicry proponents encourage the development and use of technologies inspired by natural systems and processes, the mimicry of natural patterns and shapes (bionic), the integration of natural cycles and processes in design, and to work in coexistence with nature instead of competing with or disrupting it (Fadok, 2021: 135-136). These characteristics enable the scientist quoted above to make the claim about science’s newfound capacity for endlessly taking-cum-learning from nature without depleting it. Learning is an action which can be repeated over and over, modelling new expectations about the relationship between humans and nature and between nature and technology. This relationship, due to its mimetic and cooperative character, is expected to be both more sustainable and economically viable than traditional extraction of physical materials. As mentioned above, this assumes that nature’s “data” are open and freely available, which ignores discussions of intellectual property rights and how new privatized data enclosures of nature and natural resources are created in the process (e.g., Goldstein and Johnson, 2014).

Finally, the pursuit of biomimetics and biomimicry approaches displays how the specific views of a forest espoused by salvage technoscience initiatives often claim to be holistic. As was the case with salvage anthropology, salvage technoscience stresses the importance of the exotic and of saving it from extinction, even if salvage technoscience pursues the discovery and salvaging of scientifically unexplored plants, processes, and systems rather than cultural traditions. The reliance in the above-mentioned excerpts, with their embrace of biomimetics and biomimicry, on the Amazon as latent intellectual and material wealth exemplifies the dual

[11] The speaker uses biomimetics and biomimicry (in Portuguese, *biomimética* and *biomimetismo*) interchangeably during the talk.

meaning of salvage. It ensures salvage both as conservation and as the extraction and accumulation of wealth.

7. Technological applications for conservation

Recent technoscientific approaches to the Amazon are intimately intertwined with current technological breakthroughs, where both large corporations and smaller start-ups introduce initiatives with the aim of salvaging. It is not a coincidence that a view of the forest as a repository of knowledge emerges in parallel with new information technologies frequently lauded as potential saviours in a diversity of critical arenas including "ICT4D" (Information and Communications Technology for Development), climate change mitigation, and "e-government". The Genomics Creative Lab under Amazônia 4.0 is a good instance of how technological applications are enmeshed with scientific interest and value-laden research practice. The Lab is part of both the economic and the intellectual importance placed by Amazônia 4.0 in the creation of repositories of genomic data (Nobre and Nobre, 2018). Like other Creative Labs, it is prepared for installation among local communities that would receive training and equipment to become data collectors and to start the procedures for data processing of DNA sequencings. The information generated is then expected to be purchased by different entities such as corporations or public organizations.

What is relevant here is the way in which Amazônia 4.0 claims that it will solve a long-lasting problem of extraction of knowledge from and alienation of local populations in the Amazon region, when it comes to the ownership of genetic material. It has partnered with computer science researchers from a Brazilian University, who have developed a blockchain-based digital architecture that will encompass all steps and actors involved in the DNA sequencing (Kimura et al, 2023). The idea is that the actions of the "system players" will be stored and encrypted as the data flows from collectors to buyers, with remuneration distributed in the form of a cryptocurrency once the data is bought or used in any way (idem: 7).

As in biomimicry, salvage technoscience considers the knowledge embedded in the forest's life forms as "free" to be discovered and deployed for economic exploitation. While the forest in its material form is acknowledged as (often) the property of traditional communities, the data and information that it holds is seen as both part of a global commons and as now made valuable as digital commodities. Additionally, one can read how technical applications in Amazônia 4.0 are also being developed with values such as democracy, transparency, and

fairness (benefit-sharing) in mind. For its creators, it is a technology such as blockchain which guarantees the fulfilment of both economic and ethical values in a way not previously possible.

Our second example of IT entrepreneurs engaged in salvaging the Amazon is that of Moss.Earth, a Brazilian climate tech created in 2020. Moss.Earth shares Amazônia 4.0's views on the failure or incompleteness of state-led conservation projects. In a video, its CEO tells the audience that "solutions based on philanthropy, waiting for government oversight, and hoping that somehow society will be aware of it somehow will not work because it has never worked" (Moss.Earth, 2023). And on the company's website one can read about the urgency that justifies the salvaging and the means to do so: "The clock is ticking. And every minute, more than 1000 trees are felled in the Amazon. Technology is our answer to the urgency that the planet asks for" (Moss.Earth, 2023). In contrast to Amazônia 4.0, Moss.Earth relies almost solely on technological solutions, which includes a variety of digital platforms and interfaces, data processing tools, remote sensing technologies and distributed ledgers (blockchain) to support and optimize carbon offsetting and other environmental services. These frequently rely on the generation and selling of credits or tokens to outsiders interested in financing the protection of forest tracts thus laying claims to the forest "from above". Moss.Earth thus also exemplifies a broader intensification of the use of digital technologies in forest management as demonstrated by several of the other contributions to this volume (see also Gabrys, 2020).

Moss.Earth claims to be responsible for the first tokenized carbon credit in the world, MCO2, which is listed on major exchanges such as Gemini and Coinbase. The tokenization process does not change the overall process of certifying carbon offsetting projects, but it provides a digital version of the credit that is traceable and auditable using blockchain. As a white paper from the company specifies "The MCO2 Token does not bring innovation to markets or trading, but rather innovation in usability for offsetting" (Moss.Earth, n.d.). The money that is then collected is said to be directed to registered conservation projects in the Amazon.

Another of Moss.Earth's creations is the Amazon NFT (Non-Fungible Token). Moss.Earth has acquired a corridor of forest cover of one million hectares that they see as part of a potential conservation wall against deforestation caused by agricultural and animal rearing frontiers, and each NFT corresponds to one hectare of the acquired corridor. In buying NFTs, Moss.Earth's clients become owners of land plots "with a firm commitment of preservation" (Moss.Earth, 2022), meaning that land can only be used for conservation goals. Preservation on the part of the NFT's buyers would be guaranteed since owners of the plots can at most visit them but

cannot use them for any other purpose. In addition to that, Moss.Earth also claims that part of the profit from the sales of NFTs will fund the monitoring of the land by foot and satellite.

Salvage is in this case present both as conservation, and as (digital) extraction of value when insertion of the forest into a market economy is considered the prerequisite for effective conservation. As the CEO of Moss.Earth explains:

> "The reason why the Amazon is deforested is because it is profitable (…) How do you combat this. You have to make conservation per hectare more profitable and carbon credits do that. When one conserves and certifies that conservation through an international protocol recognized in any country in the world, one can generate around 500 Reais per hectare [around 100 USD]. Then the offer becomes competitive in comparison to burning the forest, and we change the game. There are several areas where we have worked on preservation projects and generated carbon credits and the person is making more money doing that than selling their land for soybean cultivation or raising cattle. We found the solution; the answer is carbon credits" (Moss.Earth, 2023).

Salvaging the Amazon, as the CEO of Moss.Earth observes, must in their view be about making conservation profitable for those that can potentially damage the forest. Technologies can – again in their view – bring legitimacy and trust to the process of carbon credit acquisition, while giving the credits a state-of-the-art digital existence in markets, which allows them to be tracked. This adds up to the other salvaging mechanism of re-selling forest land in the form of NFTs to private owners committed to, but also juridically impeded from, exploiting their acquired property. Salvaging the Amazon is here envisioned as a process of systematic privatization of its territory into one-hectare plots, a process rendered efficient by distributed ledger technology and NFTs.

In this and in the previous case, blockchain technology and satellite imagining are both used for bookkeeping and monitoring with the digital technologies considered powerful tools to promote visibility, transparency, and trust (see MacKenzie, 2004). Hence, this technology-enabled vision is associated with a specific digitally driven understanding of, and desire for, transparency and accountability (see Adams, 2019; Gabrys, 2020). While this sounds good in theory, it further exemplifies the belief that salvage technoscience can combine the needs for preservation with (market) profits. Other cases of NFTs deployed for tokenization of forest land have not prevented the technology from masking outright fraud in terms of forest

ownership (see Fabio, 2022). Nor do these technological interventions – blockchain or NFTs – pay attention to the critical problem of whether offsets help reduce global emissions at all. Carbon markets and carbon trading has been severely criticized by social scientists for the embedded logic of accumulation, the market designs, the detachment of market trading from actual implementation of projects "on the ground", as much as for ways such schemes allow (Western) corporate emissions to continue (e.g. Lohmann, 2011; Ehrenstein, 2018; Ervine 2018; Dalsgaard, 2022). As of today, it is unclear how Moss.Earth differentiates itself from these general criticisms of offsetting initiatives and mechanisms.

Conclusion

The Amazon is consistently presented as a key entity in the fight against climate change (Bryce 2023). It is in this context that technologies emerge as tools for salvaging the forest in the hands of initiatives such as Amazônia 4.0 and Moss.Earth. We will highlight two shared characteristics. Firstly, they assume that conservation should be included in capitalist circulation if it is to be effective. Secondly, they trust technoscience to offer the means to salvaging the Amazon in the dual sense of conservation and extraction. While their visions are still only sparsely implemented "on the ground" and therefore cannot be assessed for their impacts, it would be no surprise if the relationship between the two meanings of salvage is not symmetric. A rhetoric of conservation has in other contexts been seen to mask processes of extraction, dispossession and creations of new enclosures (e.g. Kelly, 2011; Fairhead et al, 2012), which could be the case as well for the recent technoscientific approaches (Goldstein and Johnson, 2014).

Salvage technoscience, like past ideals of salvage anthropology, attempts to save objects from extinction, but there are of course differences. Colonial salvaging placed endangered (but existing) cultures into the past through practices of recording and collection allowing cultures to continue to exist in memory. For technoscientific salvaging, in contrast, what is being salvaged is preserved insofar as it can be digitally replicated, stored, distributed and, finally, sold (cf. Birch and Muniesa, 2020). For example, Amazônia 4.0 envisions the use of biomimetics to extract molecules from nature and replicate them artificially. They see in such technological advancements the potential to extract information from nature without doing any intensive material resource extraction. In comparison to colonial salvaging, the reliance on digital versions of the object to be salvaged is directly focused on markets, where the material object itself is not traded. Moss.Earth likewise relies on the digital recording of nature, and

their NFTs are aimed at leveraging international finance for conservation to take place. Yet as has been documented for other market- and blockchain-based approaches to conservation, this risks pushing the forest in the background while focusing on "the real source of value" of the financial asset, namely market demand. The NFTs may thus end up as a symbolic and economic abstraction without connection to the material nature of the existing forest or to the lives of people living there (see Howson et al, 2019). Altogether, this market-focused digital replication means that the cultural and natural entities are preserved in an uncertain present with their value depending on fluctuating demands.

The notion of salvage technoscience that we introduced in this text helps analyse the contemporary transformation of the relation between conservation and extraction. The analysis shows that, in the wake of the technoscience efforts we have described, the forest has the potential to be turned into further resources for capitalism even when it is imagined as vulnerable, and conservation and social development are presented as the main goals. While deforestation and other material forms of extraction such as mining may indeed be reduced by the initiatives of salvage technoscience, their capacity to extend the ways in which human and non-human forms are incorporated into capitalist circuits may lead to new problems, especially through the reliance on extraction of knowledge forms that turn information about forest lifeforms into property, and through a potential disregard of the forest's diverse inhabitants as actors with other agendas than those presumed by the technoscience initiatives.

We suggest that to further understand contemporary approaches to natural and human environments such as the Amazon Rainforest, whether for conservation or extraction, social science has a role to play in further identifying and critiquing processes that have supported salvage technoscience approaches to the Amazon. It is necessary to further pursue the question of how technoscience views the forest through the opportunities presented by new technologies and asset types and how it relates to the needs and wants of those living in and with the forest.

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