Commentary

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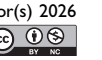

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Smart adaptation or data colonialism? Interrogating the role of digital technologies in climate adaptation

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Abstract

Highlighting a gap in adaptation studies regarding the role of digitalisation and datafication in environmental and climate governance, we argue for the need to critically engage with the ever-expanding experimental territory of *smart adaptation*. To accomplish this task, we emphasise the need to forge new alliances across the fields of digital geographies, political ecology, and political economy. We trace a genealogy of the discourse on smart adaptation and highlight how the basic premises on which mainstream approaches to adaptation operate (*neutrality* and *naturalization*) have been articulated through digitalised approaches since the very outset (through the 'climate service paradigm'). This articulation relies upon the need of ever-expanding data supplies, the creation of data relations across scales and space, and the transformation of data into a source of value. Foregrounding the figure of the 'smallholder farmer' in adaptive development, we outline three modalities through which smart adaptation operates: *depoliticization*, *financialization* and *experimentation*. Finally, we call for the need to put adaptation scholarship in dialogue with the emerging field thematizing data colonialism as an analytic device to shed light on extractive processes of datafied capital accumulation and dispossession which stem from the conjoined coloniality of climate change and digital infrastructures.

Keywords

Climate adaptation, digital geographies, data colonialism, climate services, climate-smart agriculture

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Digitalising climate adaptation

Like most domains of (more-than-) human life, the field of climate change adaptation has seen a proliferation of digital technologies and 'smart' interventions. A wave of digitalisation and 'appification' has swept across sectors and agendas involved in and related to adaptation, with applications and interventions that range from smart irrigation systems combining soil moisture sensors and weather data; agro-advisory apps combining satellite and user-generated data, precision agriculture technology, and chat-boxes powered by generative Artificial Intelligence (AI); advanced index-based micro-insurance schemes for small-scale farmers; digital water management platforms. Beyond their ostensible heterogeneity, these 'smart adaptation' interventions are ultimately justified and advertised as technologies and practices that "enhance adaptation" (Hellin et al. 2023).

The aura of novelty and positive spin that accompanies these interventions risks overshadowing that they are intertwined with and reproduce forms of inequality that leave the epistemological and colonial underpinning of adaptation and climate services unchallenged. This becomes apparent when – following critical adaptation studies – we do not see adaptation as a set of neutral interventions, but rather, as a "regime" (Paprocki 2018, 2021), as situated configurations of power producing new relations and spaces. Similarly, the digital, as convincingly theorised also by digital anthropology and political ecology (Bettini et al. 2020; Boast 2011; Ginsburg 2008; Sullivan 2017), is not something neutral juxtaposed onto an underlying socio-ecological, cultural and economic substratum (Kitchin 2013). And yet, climate services are aggressively presented as a neutral solution to deliver information and reduce risk. As illustrated in the following, the positivist and depoliticised framing of climate change (adaptation) enabled by climate services, together with the datafication the digital entails, facilitate the production of forms of subjectivity amenable to financialization. This exposes marginalised groups to processes of disenfranchisement and dispossession that stem from and reinforce the coloniality of climate change (Sultana 2022). This commentary builds alliances for a critical exploration of how smart interventions align with and reinforce forms of adaptation that reproduce and intensify marginalisation, dispossession, and colonial relations. In doing so, we open a dialogue between critical studies on adaptation and the growing body of work on data colonialism.

Having engaged with climate adaptation for the past decade – as scholars in the Global North and as practitioner based in the Majority World, a key motivation for writing this commentary is the concern over the growing chasm between fast-paced socio-technical shifts happening through smartification, and what we, as scholars, are able to grasp, conceptualise and resist, if we do not dare venturing outside adaptation's own walls. The sectoral and disciplinary boundaries imposed by planetary climate planning can often restrict our horizon, so that transformations such as those brought about by digital technologies and big data risk escaping critical scrutiny, despite involving the very places and people that are targeted by formal adaptation interventions. This can leave major gaps, not least in relation to the justice implications of climate responses. We thus advocate a broader engagement across sectors and literatures, foregrounding the impacts of digitalisation on adaptation, the dispossession this can entail, but also the potential for digital counter-movements.

In the first section, we briefly review and map out existing literature on the digital, its links to colonial relations, and the ways in which this confluence has contributed reshaping socio-ecological relations and environmental governance. We highlight how, in spite of the insights offered by these rich bodies of literature, they seldom scrutinise how the digital has entered the specific regime of climate *adaptation*. We then introduce a brief genealogy of smart adaptation in dominant climate adaptation discourses and, in that context, trace the connection between datafication and financialization of risk, illustrating how those together can lead to forms of marginalisation and dispossession justified in the name of the imperative to adapt. To illustrate these points, we delve into

the figure of the smallholder farmer, as emblematic example of the subjectivities smart adaptation is reconfiguring. To foreground the political economy of smart adaptation, we draw on the notion of data colonialism, which offers insights into how smart adaptation and climate services can exacerbate exploitative relations along racialised and colonial lines. We conclude with some reflections on the generative and future-making character of smart adaptation, calling for more qualitative, situated and critical engagement with these developments.

Climate adaptation and digital natures

In the past decade, scholarly engagements with digital geographies and digital-natures (Luque-Ayala et al. 2024) have flourished, with strong calls for "repoliticising the technological turn in sustainability governance" (Rodima-Taylor et al. 2024). The "digital ecologies" sketched by Turnbull et al. (2022) provide us with a comprehensive overview and analytical framework for mapping digitally-mediated human–nonhuman entanglements, as we set out investigating this articulation in the realm of climate adaptation. Notably, important conceptual frameworks stemming from political ecology trace how value is extracted from nonhumans online (Büscher 2014). Work on "feminist digital natures" (Nelson et al. 2022) alert us to the central role played by socio-ecological relationships as mediated by power, emotion, and embodiment. Key contributions have for instance addressed technologically enabled knowledge practices/methods in wildlife conservation (Arts et al. 2015; van der Wal and Arts 2015), and analysed 'smart forests' as technologies for addressing environmental and climatic change (Gabrys 2020, 2021).

Whereas the impacts of datafication on the broader field of climate governance have been explored in some detail, the role of digital technologies in climate *adaptation* remains unexplored in most of these contributions. Scholars have exposed the dominance and shortcomings of algorithmic reasoning in climate policy and governance through the analysis of global blueprint initiatives, like the Data for Climate Action campaign (Espinoza and Aronczyk 2021), the Rockefeller Foundation's 100 Resilient Cities program, and Microsoft's AI for Earth (Nost and Goldstein 2021; Nost and Colven 2022). The silent and yet pervasive role of digitalisation in global policy processes like Loss and Damage has also been highlighted (Bettini et al. 2020). However, climate adaptation as such does not feature explicitly or prominently in any of the analyses of "digital ecologies" (Turnbull et al. 2022) and climate governance. We argue that the call for a "political ecology of data" (Machen and Nost 2021) – alert to the socio-technical assemblages that structure and create knowledge algorithmically – is vital also in relation to the field of climate adaptation. Yet the myriads of adaptation interventions proliferating on the ground and across sectors and geographies are rarely seen through this lens. In the next section we argue that this invisibility in plain sight is genealogically situated in the climate service paradigm and the epistemological field that birthed adaptation in the first place.

Neutrality and naturalization: A brief genealogy of smart adaptation

The first element we would like to establish is the interlocking of hegemonic framings of climate change, the digital, and the depoliticization of adaptation, with climate services operating as a key device weaving those elements together and reinforcing their dominant position.

Since the 1970s, technological advancements have radically boosted scientists' ability to understand and forecast the Earth System; increasingly sophisticated digital technologies, including satellites, radar, telecommunications, and supercomputing, have been pivotal to 'discover', visualize, quantify and predict global warming (Demeritt 2001; Lövbrand et al. 2009; Edwards 2010; Gabrys 2016; Rothe 2017). In this evolution, digital technologies have been far from ancillary or neutral: not only they have played an essential role in visualising and modelling global

warming, but perhaps equally importantly they contributed shaping the very definition of the problem of climate change as 'we' – the Western 'modern' subject – know it, and thereby of the 'solutions' deeemed legitimate. Hulme (2017) refers to this epistemic assemblage as "climate reductionism": climate change is assigned the role of dominant predictor variable in an otherwise uncertain and yet immutable world and is reduced to an external natural *threat* to be quantified and modelled through ever-perfecting science and *data* (Demeritt 2001; Nightingale et al. 2019; Chakraborty and Sherpa 2021). From this stems three direct corollaries with far-reaching impacts: (i) addressing climate change is understood as based on the calculation of *risk* and quantification of *impacts*; (ii) therefore, it is assumed that more data will enable 'better' interventions, and (iii) forms of knowledge and framings not compatible with Western techno-science are marginalized, or assimilated as 'data' (Latulippe and Klenk 2020).

Climate services have represented a key device weaving those elements together and reinforcing their dominance. Defined as the production, elaboration and sharing of digitised information to help individuals and organizations making "climate-smart decisions" (Hewitt et al. 2012; Brasseur and Gallardo 2016), climate services have become pervasive, from the private sector to dominant service providers, like the Copernicus Climate Change Service (C3S). The 30 years spanning from the First World Climate Conference (1979) to the Third (2009) – which marked the endorsement of the Global Framework for Climate Services – forged the lens through which climate change is hegemonically framed and addressed. A complex assemblage was consolidated and institutionalised through international processes (organizations, policy summit, academic conferences and journals, etc.), of which the Intergovernmental Panel on Climate Change is one of the most representative instantiations (Lövbrand et al. 2009), as well as through infrastructural expansion, with the proliferation of data centres supporting national, regional, and private climate service centres.

Adaptation – at least in its mainstream articulations – is a direct emanation of what we earlier referred to as the climate reductionist discourse. Predicating the constant need for the world to adapt to the inevitable disruption and changes that the climate emergency is and will be causing, hegemonic discourses on adaptation are informed by the positivist risk / impact framing, showing the imprint of the three corollaries above. The focus on impacts *naturalises* the root causes of vulnerability, transforming history into nature. Furthermore, the digital production of scenarios and solutions is portrayed as *neutral*: it relies on the normative assumption that 'optimal' solutions and techno-fixes allowing places and people to become adapted *exist* and can be determined through better information (*data*). Here the fallacy according to which more information, or better data, will 'solve the problem' goes hand in hand with epistemological domination on the part of Western science and policy solutions compatible with such episteme, straightjacketing possible approaches to the climate emergency within the boundaries of depoliticized techno-managerial fixes (Olazabal et al. 2024). Scholars across geography and the social sciences have pointed at the implications of the imperative to adapt, highlighting how the adaptation discourse occludes political struggles and conflict and promotes depoliticised governance (Taylor 2014), operating through context-blind and short-lived techno-fixes (Eriksen et al. 2015; Nightingale et al. 2019), that are ultimately instrumental to the preservation of the socio-political status quo (Swyngedouw 2022).

Smart adaptation stems from the unholy marriage of the positivist, reductionist framing of climate change with the broader proliferation of "digital solutionism" (McLean 2020) – i.e., the assumption that more and better data leads to more cost-effective (just, transparent, participatory, timely, etc.) interventions. Heralded as low-hanging fruits able to facilitate and accelerate the set of non-political transformations needed to build resilience, justified by the sense of urgency conveyed by the climate emergency, and building on the belief (fallacy) that more granular information will lead to 'better' decision-making, smart adaptation initiatives are integral part of the "climate adaptation regimes" (Paprocki 2021) that increasingly shape the series of interventions through which adaptation is producing new spaces, relations, and subjectivities.

Smart adaptation and the datafication-financialization nexus

A watershed moment facilitating the proliferation of smart adaptation was the 2007–09 financial crisis. In its aftermath, expanding access to finance became a mantra in the international Development agenda (Aitken 2022; Bernards 2022), with financial inclusion tools becoming more prominent than ever also in the agenda of international agencies and actors responding to climate change. This led to a sensible intensification of the global push for climate services and smart solutions for 'vulnerable populations' and 'marginalised groups', as enshrined in the Global Framework for Climate Services, which was revealingly endorsed in 2009.

The push in this direction has been significant, with the cementing of the nexus between *datafication* and *financialization*. Actors at the intersection of climate resilience, adaptation and international development have heavily incentivised smart and digital applications. This typically entails the creation of temporary assemblages of private companies, governments, technology and research initiatives (Nost and Colven 2022), absorbed in the never-ending cycle of piloting the latest technological innovation. This type of smart adaptation interventions are usually examined (or we should say heralded) by technical reports and normative grey literature that fail to offer a grounded and critical understanding (for context and on the lack of peer-reviewed literature on climate services, see IPCC 2021: 1862ff).

One aspect that deserves attention is the *transformative* character of this paradigm, and the new relations and subjectivities it generates. Even techno-managerial discourses acknowledge the profound nature of the changes, and transforming vulnerable populations into adaptive subjects by merging socio-economic development with resilience has become an explicit goal in many policy visions and platforms. Calls for "Adaptive Development" (Agrawal and Carmen Lemos 2015) or "Climate Resilient Development" (IPCC 2022) have proliferated over the past decade. Adaptation is predicated upon the discursive production of certain places and populations as especially *vulnerable* to the effects of climate change (Taylor 2014), which paves the way for making such groups 'targets' or 'users' that are both at risk and in need of interventions, *as well as* agents of resilience. Adaptive Development finds an embodiment in the adaptive and resilient subject, expected to improve their situation also through climate-smart decision making, which is inevitably mediated by algorithmic governance and GIS-based climate visualization, forecast and simulation models. In particular, their ability to become adaptive subject relies on the predicament that more certain, granular, visualized, easy-to-access, 'scientific' information will make their decisions 'smarter'.

Adaptation as a service: Reshaping the farmer via datafication and financialization

The figure of the smallholder farmer - often gendered (Nelson et al. 2024) - is paradigmatic: framed as the vulnerable subjects and yet the 'heroes' of Adaptive Development, farmers are to be supported by conjoined interventions aiming at once at poverty reduction, food security, and climate resilience. This is the triple-win mantra that in various incarnations informs most of the literature and practice promoting Adaptive Development. The narrative is seemingly compelling: climate risks are mitigated *and* agricultural productivity/food security is increased *and* poverty is reduced. Inspired by FAO's approaches to climate smart agriculture, initiatives targeting smallholder farmers and promoting climate-smart villages have been launched across the Majority World, with the proclaimed goal of equipping "communities with tools to improve their resilience to climate change and other changes and foster sustainable development, particularly of agriculture" (ICIMOD 2015). Making a village 'climate-smart' hence means to implement "portfolios of climate-smart agricultural practices, technologies, and services, which can be combined together to make the best out of an increasingly difficult situation" (CGIAR 2015). The rationale behind

these interventions is staunchly anchored in techno-fixes and the belief that predicting and managing threats in more cost-effective and accessible way is a matter of acquiring and accessing more and better data, in a socio-political vacuum.

A few studies have started scrutinizing and situating the role of digitalisation in adaptation initiatives targeting the agricultural sector in the Majority World (Karlsson et al. 2018; Taylor 2018). Climate services, and the consequent reconfiguration of agrarian subjectivities "towards digital, service-based agriculture in the form of Farming as a Service" (Malik 2023: 546), are at the frontline of new forms of dispossession that proceed though datafication. Under the banner of digitalisation and covered by the aura of novelty and hype that surrounds it, climate-smart programs have been prone to exacerbating existing inequalities along lines or race, class, gender and caste, often becoming part of far from emancipatory agrarian transformations (for a lucid analyis of these tendencies in the Indian context, see Malik 2023). The reframing of specific technologies as relevant to the management of climate risks allows the restructuring of existing sets of practices and interventions so that they become amenable to capital accumulation through datafication. So, for instance, repositioning agrarian questions through the lens of climate risks and adaptation as mediated by climate services, creates the conditions for the penetration of agro-tech firms converting agricultural data into a private asset, ultimately shaping agrarian futures through the lexicon of "surveillance capitalism" (Stock and Gardezi 2021). This trend is even more explicit in the mushrooming of digital credit scoring in agriculture whereby private companies appropriate farmer-level data collected from digital channels to evaluate and rank potential borrowers in order of their likelihood to repay a loan (Okeyo et al. 2023). The recent attention and hype around AI and Large Language Models (LLMs) have not spared the field. Key actors such as the World Bank and the World Economic Forum (WEF) as usual lead the way and have re-branded their approach to smart and climate resilient agriculture introducing the new technological development, with the WEF suggesting nothing less than that "AI can catalyse the next agricultural revolution"[1]. The UNFCCC has launched the Technology Mechanism Initiative on AI for Climate Action (#AI4ClimateAction), a multi-year programme aiming to "leverage AI technologies to drive transformative climate solutions, with a particular focus on mitigation and adaptation efforts in developing countries, especially LDCs and SIDS" (UNFCCC 2024). While AI unquestionably opens new questions concerning speed, data appropriation, carbon footprint, etc., and while heralded as novel, at the forefront of the current technological development, these AI-powered initiatives and interventions largely follow and reproduce the logics described above.

A field of particular interest is that of agricultural insurance, where the financialization through datafication of climate adaptation is most tangible in the development of sophisticated platforms offering weather-indexed insurances and agroclimatic advisory for those identified as vulnerable farmers. The attempt to render vulnerable populations 'insurable' subjects continues to be saluted as the next frontier at the intersection of climate adaptation and poverty finance, whereby FinTech's largely unsuccessful attempts to incorporate micro-insurances in their practices (Bernards 2022) are rebranded as efforts to manage climate risk for vulnerable, uninsured lives (Aitken 2023). The multiplication of parametric climate risk insurance (based on increasingly sophisticated index-based insurance schemes often using machine-learning to deliver climate risk information) is exemplary. Weather-indexed schemes are developed in assemblages of banks, insurers, re-insurers, food companies and farmer cooperatives, "teaming up with European universities and research centres to find ways to increase resilience in supply chains, in a way that protects smallholder farmers from climate-driven risk and losses".[2] Digital support enabling Earth-observations and their communication are the technology through which, along the chain of actors involved, climate risks are constructed, visualized and translated into financial objects.

The aura of novelty and hope that still surrounds technologies and schemes that have been piloted across the globe for over a decade tells us something about their infrastructural role in

the politics of climate adaptation/Adaptive Development. Despite repeated failures in delivering pay-outs and reaching the most vulnerable (Johnson 2021, 2022; Bergsvik and Kloppenburg 2024), parametric insurances continue to be marketed as winning solutions in climate adaptation regimes, across scales and sectors (Bracking 2019; Bernards and Mbungu 2024). Perhaps, as argued by Aitken (2023), weather-indexed microinsurance should be interpreted less as products to conquer financially the countryside and extract surplus from the uninsured, and more as "infrastructure of concessionary transfers from the development sector to make market-mediated mechanisms work" (Johnson 2022: 1224). In essence, they are witness to new configurations of alliances between donors, states, and insurance capital, and their failure 'on the ground' are hence not failing the main purpose of the initiatives targeting Adaptive Development.

Data colonialism and the coloniality of climate adaptation

A key aspect that deserves further attention is how the political economy of smart adaptation and climate services intersects with unequal power relations, colonial legacies and their operational racialised logics. There is now widespread recognition that the very phenomenon of global warming is rooted in the long history of colonial oppression and extraction of resources, in what many refer to as racial capitalism (Gilmore 2007). The colonial roots of today's uneven geographies of vulnerability and the skewed distribution of financial resources and decision-making power have been exposed (Chaturvedi and Doyle 2015; Sultana 2022; Parsons 2023), and acknowledged even by the Intergovernmental Panel on Climate Change (IPCC 2022). Contextually, Black ecologies have equipped geographical thought with the tools to analyse the political economy of climate change adaptation in the contest of racial capitalist violence and extraction that emerged through plantation slavery (McKittrick 2011; Purifoy 2021). The urgent question here appears to be around the role of digital infrastructure in reinforcing and reinventing colonial forms of extraction and domination – epistemological, economic, political – through datafication. We argue that the basic premises on which mainstream approaches to adaptation operate (*neutrality* and *naturalization*) have been articulated through digitalised approaches since the very outset ('climate service paradigm'). This alliance comes with an urgent need of ever-expanding data supplies, the creation of data relations across scales and space, and the transformation of data into a source of *value*. It is precisely at this conjuncture, that we call for the need to put adaptation scholarship in dialogue with the emerging field thematizing data colonialism as an analytic device for "dynamics of simultaneous aggressive integration through growth and infrastructural exclusion, or the intensification of data relations" (Brodie 2023: 6).

Couldry and Mejias define data colonialism as "the extension of a global process of extraction that started under colonialism and continued through industrial capitalism, culminating in today's new form: instead of natural resources and labour, what is now being appropriated is human life through its conversion into *data*." (Couldry and Mejias 2019: xix).

Digital access, according to geographers (Thatcher et al. 2016), acts to bring new users into a system of data colonialism, enacting a familiar geographical dynamic of coloniality – not only does data follow existing routes of colonial exchange, its dynamics of overaccumulation, investment, and dispossession occur through emergent regimes of digital data exchange whereby governments, non-governmental organizations and tech corporations claim ownership of and privatize the data that is produced by their users and citizens (Kwet 2019; Der et al. n.d.), while exerting infrastructural control (Brodie 2023). The convergence of the rubrics of climate adaptation and Development ("Adaptive Development") and their largely overlapping institutional apparatuses and infrastructure, is intensified through the production and dynamics of data.

Digital platforms facilitate the joint datafication and financialization of adaptation, making it into a field for the extraction, elaboration and commercialization of data (generated by users), a new

frontier for "platform capitalism" (Srnicek 2017), as illustrated in the examples above. As the funding and attention devoted to adaptation continue rising, we can see the emersion of forms of "accumulation by adaptation" (Eriksen et al. 2021: 4) that reproduce dispossession and the very colonial matrix from which vulnerability – and the difficulty adapting to impacts – stem in the first instance.

Significantly, the alliance between the neutrality of the digital, the naturalization of vulnerability, and the depoliticization of adaptation / Adaptive Development, perpetuates climate coloniality through various form of value extraction and capital accumulation that might benefit a few, while dispossessing the majority in the Global South and in racialised geographies in the Global North. Therefore, adaptation can offer an example of how the coloniality of climate change and data colonialism intersect in generative ways – that is, in ways that not only reproduce historical inequalities but also produce new forms of exploitation and dispossession. Digitalization practices often reflect a single epistemological authority that perpetuates long-standing forms of extractivism and domination (Benjamin 2019; Young 2019) which lie at the root of poverty and vulnerability. While information/knowledge is delivered/constructed in the global North, collecting and processing/aggregating data to produce climate information, risk is downstreamed towards historically marginalized and dispossessed groups (e.g., smallholder farmers), at the frontline of adaptation.

These multiple dimensions are clear when considering how on the one hand local elites access the benefits of the adaptation regime, and on the other less powerful groups are exposed to various forms of dispossession, whereby colonial logics of extractivism continue through Adaptive Development interventions (Paprocki 2021; Mikulewicz 2024).

From a spatial angle, data colonialism comprises processes that are global and relate to international power gradients (not least along the North-South direction) and "postcolonial space-times" (Sultana 2022) that are also internal to countries. There is an undeniable dominance by corporate actors and forms of knowledge emanating from and based in the Global North, and the subsequent geographical imbalances of digital data infrastructure (Brodie 2023), but also significant dimensions emerging within colonised and postcolonial places (Ricaurte 2022). This internal dimension is important, as otherwise the risk is to flatten landscapes in the Majority World, obliterating local unequal relations and drivers of marginalization but also the agency of local and national actors and institutions. It is also crucial to remain open to the possibility of the emergence of counter-discourses and practices (Sullivan 2010), that can also be digitally produced. A notable and hopeful case is the emerging "digital indigeneity" of Inuit groups in Canada, who have attempted mobilising digital tools to resist and challenge top-down climate adaptation in the Arctic, pushing alternative and decolonized articulations of "Arctic resilience" (Young 2021)[3].

The foundational role of digital technologies in articulating the technoscientific rationalities and epistemologies of mainstream forms of adaptation shows that data colonialism is an inherent and fundamental dimension of the coloniality of climate change. As digital economies expand, including emerging forms of "AI colonialism" in the global south (Hao 2022), we agree with Couldry and Mejas that we find ourselves on "the verge of a new stage of capitalism that as yet we can barely imagine" (2018: 337). At that point, the appropriation of human life through data will certainly be deployed and justified via the infrastructural and epistemological arsenal through which the climate crisis is articulated. Ultimately, the underlining rationality of "accumulation by dispossession" (Harvey 2004) and "accumulation by adaptation" (Eriksen et al. 2021) is now operating as "datafied accumulation" (Brodie 2023).

Conclusions: Depoliticization, experimentation and future-making

One of the main aims of this commentary is to highlight the importance of forging an alliance between critical scholarship on digital ecologies, data colonialism, and on adaptation, respectively.

While all these fields are well-established and offer insights our analysis heavily draws on, they seldom talk to each other. The need to contextualise and politicise adaptation, pluralise climate knowledges and epistemologies, and ensure cognitive justice (Santos et al. 2007; Burman 2017), emphasised by critical adaptation scholars (Hulme 2018), should also encompass climate services and smart adaptation. The significance of the gap this commentary highlights does not amount to a simple sum of the importance of the two fields – with the pervasive diffusion of the digital and the sprawling reach of adaptation on the ground, respectively. As we have detailed, the positivist, reductionist framing of climate change and the broader proliferation of "digital solutionism" (McLean 2020) converge and reinforce each other to crystallise depoliticized forms of adaptation. Smart adaptation and climate services operate under the garb of neutrality (technology) and naturalization (root causes of vulnerability), which together foreclose the fact that smart adaptation and climate services are far from neutral or innocent techno-fixes. They are future-making devices. They produce new practices and spaces, and reconfigure socio-ecological relations, not seldom leaving in their wake dispossession.

In particular, by tracing the consolidation of the datafication-financialization nexus and exemplifying its impacts on *vulnerable* farmers, our reflections cast serious doubts over the hope that digital and smart interventions can lead straightforwardly to inclusive adaptation, and in the last instance the empowering of the most vulnerable. At a closer look, mainstream smart adaptation and climate services, as an assemblage of discourses, technologies and practices, appear dangerously aligned with extractive colonial relations and data colonialism. When scrutinised from a critical angle, the climate services paradigm and smart adaptation seem like a case in point for the tendencies by hegemonic adaptation discourses to gloss over inequities and injustices and perpetuate the status quo. The call to address risk and vulnerability through allegedly neutral expert-techno-driven initiatives and techno-managerial approaches contributes masking such power effects (Nightingale et al. 2019; Mikulewicz 2020; Ojha et al. 2020).[4]

The proliferation of generative AI can be expected to reinforce the push for the digitalisation and datafication of adaptation. The hype on generative AI-powered apps can provide further traction to smart adaptation, refreshing its aura of novelty (on AI in agriculture, see for instance El Jarroudi et al. 2024; Krishnakumari and Shah 2025). The drive to appropriate data to train models can be a further incentive for the tech industry to move into the sector. The processes of dispossession (material, economic, cultural) that accompany large scale AI risk being amplified in a context such as adaptation where, per definition, 'users' tend to be exposed, less powerful groups.

One element that can result puzzling when considering the impact of the digital in the adaptation field is the fact that many of the projects on the ground seem perpetually stuck at the pilot stage, very seldom reaching a full scaling up. It is rare, in the technical reports and normative grey literature that promote smart adaptation, to find an evidence-based discussion of the outcomes. One is left to wonder what projects, emphatically launched as groundbreaking and transformative (see e.g., smart index insurance schemes), really entail in the long run and beyond the usually small groups of participants / users involved. As of now, they certainly entail the conversion of climate uncertainty into risk, what Sarah Bracking refers to as "a risk-based orientation to expectations of the future" (2019: 709) aimed at furthering financial capital.

It is tempting to see this character as a dysfunction and sign of failure. However, and crucially, to be effective the future-making power of digital adaptation does not necessarily require the complete fulfilment and success of the stated goal of the set intervention. Experimentation and 'governance by pilot' have been rather common in the history of fields such as Development, poverty finance (Bernards 2022), or urban adaptation (Datta 2022; Henrique and Tschakert 2020), and Paprocki (2021) has keenly suggested to include experimentation among the devices enabling the affirmation of adaptation regimes. Experimentation – and here the hype on the novelty and promises of the smart comes to mind, together with the many 'failed' pilots one encounters when examining

empirically the field – is in itself a powerful technique for future-making, legitimising actors, affirming knowledges, producing subjectivities and relations. Ultimately, failed interventions as a manifestation of the power configurations reproduced by adaptation regimes, are indeed transforming landscapes, subsuming worlds, and imposing prefabricated futures. Visions, experiments and chimeras do not need to materialise in order to have effects, which is one of the key reasons why a critical and empirical examination of emerging digital adaptation interventions and discourses is urgent.

Highlights

This article:

1. Identifies a gap in addressing the ever-expanding experimental territory of 'smart adaptation'.
2. Invites the forging of an alliance between scholarship on the digital and on climate adaptation.
3. Provides a genealogy of the discourse on 'smart adaptation' and describes how it is rooted in the climate services paradigm.
4. Outlines three modalities through which 'smart adaptation' operates: depoliticization, financialization and experimentation.

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Notes

1. See https://www.weforum.org/stories/2025/06/ai-food-systems-agricultural-revolution/
2. Source: WINnERS - Climate-KIC Success Stories. Other examples: Index Based Flood Insurances (IBFI), in Africa and South Asia, UK funded Sibelius in Mongolia.
3. For other examples on community and counter-movements re-purposing digital and smart technologies, see a thorough mapping in Thatcher and Dalton (2022).

4. Recent seismic shifts – including the assault on climate science and the dismantling of climate policy under the Trump administration and similar governments – render, if anything, the role of digital technologies and AI even more consequential for the places and peoples at risk from the climate emergency – the *subjects* of adaptation. The political economy of data and digital infrastructure – and the rationales currently linked to those - can provide legitimacy and economic incentives that operate independently of – or alongside – the political salience and currency of climate change adaptation. In denialist political contexts, interventions might gain traction precisely because they are framed through data, efficiency, or financial inclusion rather than climate change per se, while the underlying dynamics of financialization and digital extraction proceed with or without an explicit 'climate adaptation' label.

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