Reversing the gaze on nature in an era of technological innovation

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Abstract

How nature is understood and 'seen' by governing institutions influences how it is managed. The rise of new digital and remote sensing technologies has reinforced a global gaze 'from above' that separates the seer from the people and places seen. This gaze has generated critical data on global climate and biodiversity trends and informed ambitious environmental targets. Yet it also obscures a much wider landscape of human nature relations rooted in particular places. To date, there has been inadequate attention to whether, when and how technologies can be repurposed not only to 'see' more diverse forms of caring for nature, but also to reconfigure power relations and 'count' alternative contributions towards global goals.

This paper employs the metaphor of a "reverse gaze" to symbolize a shifting of power and broadening of perspective. Our analysis draws on the illustrative case of the Kunming Montreal Global Biodiversity Framework (KMGBF), which contains both quantitative targets typifying a global gaze, and qualitative goals for equity and place-based approaches. We then draw on the literature to identify ten lenses through which global targets focus our vision and ask: (1) What forms of care for nature are missed by these lenses? (2) How might we repurpose technologies to better capture and count these overlooked contributions to the KMGBF? and (3) How might this expanded gaze contribute to more equitable and diverse approaches to governing human nature relations?

This paper shows how repurposed, pluriversal technologies can both effectively speak to, and stretch, target-centric governance. It also reflects on the political risks of visibility, emphasising that epistemic justice and co-design are essential to prevent appropriation or erasure of local priorities. It then provides conceptual roadmaps and illustrative examples to demonstrate how the reverse gaze can expand what is measured, recognised, and valued across scales. Ultimately, we argue that the proactive embedding of diverse place-based approaches into global governance, and into the ways we govern through technology, is critical for transforming power relations in ways that enable more just, plural, and resilient human-nature relations.

1. Introduction

How we view the world influences, and is influenced by, how we interact with it. Over space and time, different ideas of nature, and human-nature relations, have produced different socio-political responses (Lorimer, 2015). The rise of digital and remote sensing technologies has created a global, technological 'gaze', generating ideas of nature as something quantifiable, measurable and separable from the 'seer' - what Haraway (1988) has coined the 'god trick' of 'seeing everything from nowhere' (p. 581).

Many of these technologies were first developed as tools of surveillance for military and extractivist purposes (Fish and Richardson, 2022; Simlai and Sandbrook, 2021). They enabled powerful actors to control, or extract benefit from, distant lands, resources and populations. Increasingly, these same technologies are being repurposed to identify, measure and reverse the environmental damage caused by such extractivism (Simlai and Sandbrook, 2021). This has enabled the generation of ambitious global environmental targets (Affinito et al., 2024; Hughes, 2023; Li et al., 2023): for example, the 30x30 targets of the Convention on Biological Diversity (CBD) Kunming-Montreal Global Biodiversity Framework (KMGBF) to expand protected and restored areas to 30% by 2030 (Secretariat of the Convention on Biological Diversity, 2022), and the Paris Agreement target to limit global warming to 1.5˚C (UNFCCC, 2015). Yet many actors, at multiple scales, have argued that the repurposing of surveillance technologies to serve environmental goals must involve fundamental changes to how these technologies are used, and by whom, if they are to avoid appropriation by powerful actors in ways that are inequitable, and that undermine the environmental targets they claim to serve (Osborne et al., 2021; Smith et al., 2024).

This paper's concept of a 'reverse gaze' explores what such a fundamental change might look like. The phrase 'reverse gaze' has roots in critical tourism studies, where it refers to flipping the gaze of tourist cameras back onto the photographers, and the power dynamics driving their actions (Gillespie, 2006). In this paper we use the term more broadly, to connote reversing the gaze (and all of our senses and perspectives) from top-down surveillance to locally situated, place-based engagement, while fostering greater equity and inclusion across all scales. We draw on the case of the KMGBF 30x30 targets to consider three interlinked questions: 1) what is missing if we employ a global gaze focused solely on the quantitative elements of global targets, and why? (i.e. and through what lenses does this restrict our vision?); 2) how can new technologies (where appropriate) help make more diverse human-nature relations visible and countable towards global goals?; and finally 3) how might such an expanded gaze support more equitable and effective environmental governance?

The focus of a reverse gaze on equity and diverse human-nature relations speaks directly to the findings of the recent Transformative Change report of the Intergovernmental

Science-Policy Platform (IPBES) (O'Brien et al., 2025). Endorsed by 147 countries, this report identifies disconnection from nature, concentration of power, and focus on material gain as the three core underlying drivers of biodiversity loss and nature's decline. This same report proposes equity and justice, pluralism and inclusion, reciprocal human-nature relationships and adaptive learning and action as the four core principles of the transformational change needed to repair human-nature relations.

Furthermore, and also in line with a reverse gaze, the IPBES report highlights the importance of 'place-based conservation' in fostering 'respectful and reciprocal human-nature relationships' (O'Brien et al., 2025, pp. 8, 10, 24). Place-based approaches recognize a broader diversity of human and non-human contributions to nature than those captured through remotely generated, standardized measurement (Cole et al., 2023). They emphasize the 'relational' nature of conservation, i.e. how motivations and actions of care towards nature are embedded in social relations, values, cultures and land use practices (De Haas and Westerink, 2025). Such approaches encompass a wide diversity of ownership and management systems that include, but are not limited to, community-based and Indigenous practices (Williams et al., 2013). What they hold in common is commitment and accountability to particular social ecological landscapes. This very diversity, and the non-fungible nature of commitment to place, makes it difficult to quantify the contributions of placed-based approaches through dominant surveillance technologies. As a result, many critical contributions to nature are not 'counted' towards global targets and risk being crowded out or undermined by other actions (Cook et al., 2025; Ellis et al., 2025; Moon et al., 2025).

As we explore in this paper, however, a reverse gaze perspective reveals new opportunities, including new ways to repurpose technologies, to better recognize and support place-based actions. To explore these opportunities, we draw in part on a large and growing body of literature on repurposing technology. For example, Turnbull et al.'s work (2023) on 'digital ecologies' examines the conditions under which digitally mediated human-nature interactions have served progressive agendas. Chandler (2018) refers to the "hacking" of technologies, where people explore, adapt, and repurpose established tools or structures to create new, sometimes unintended, ends. Our paper adds to this literature, by exploring the relationship between repurposing technologies and the pursuit of nature-related global targets, and whether and how the two might co-exist in ways that support more equitable human-nature relations.

Our analysis is grounded in the KMGBF for multiple reasons. The KMGBF includes a 2050 Vision of living in harmony with nature and four global goals for 2050, as well as a mission of reversing the loss of biodiversity by 2030, with 23 action-oriented targets to be achieved by this date. These targets include a mixture of time-bound and quantitative goals as well as qualitative elements addressing equity and inclusivity. They cover a range of actions from expanding protected areas and restoration activities, to promoting

sustainable production and consumption, to equitable benefit-sharing of genetic resources, and the generation of sustainable finance.[1] The KMGBF also promotes nation-specific objectives and local contextualisation (Affinito et al., 2024). Thus as a whole, and consistent with the goals of this paper, the KMGBF aims to combine a global gaze with other ways of seeing, creating knowledge, and governing human nature relations.

Yet making room for such a diversity of goals and objectives, requires first addressing the distinct ways in which quantitative targets serve to focus, and hence narrow, our vision. As observed by Smith et al. (2024), a core normative imperative of global nature-related targets is that they be "**SMART**", i.e. **S**pecific, **M**easurable, **A**chievable, **R**ealistic and **T**imebound. These features help make progress 'legible' and politically salient at a global scale, allowing actors to measure and compare national progress, regulate industry, re-direct finance, and channel development aid (Fukuda-Parr and McNeill, 2019). Yet the perceived political importance of targets as tools to hold states and the private sector to account, has also driven a 'target-centrism' that is susceptible to appropriation and risks drowning out other global goals and processes critical for equity, diversity and inclusion (Bartlett et al., 2012; Smith et al., 2024).

This drowning out of other values (Bartlett et al., 2012) arises from how SMART targets frame our understanding of space, time, finance and the nature of knowledge. They emphasize rapid speed and large-scale actions; measurable, fungible and tradable exchange; and the production of quantitative data through the application of Western science and digital technology (Hickel, 2019; Jasanoff, 2010; Pienkowski et al., 2024; Smith et al., 2024; Turnhout et al., 2014). This produces a series of lenses through which certain types of contributions to nature are recognized, and not others (see Box 1).

[1] The full text of the KMGBF is available here: https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf

Box 1 Ten lenses of Smart Targets that narrow the global gaze

Space:

1) '**scaling up**' standardized interventions;

2) measurable, **area-based targets** for protecting 'high priority' areas (e.g. for biodiversity or forest carbon) that are defined by natural science assessments dis-embedded from local contexts and priorities;

3) the legal designation of protected areas within **fixed boundaries** that overlook informal and place-based human-nature relations not recognized in formal state records and processes;

4) the rendering of ecosystems and their contributions as **interchangeable** and tradeable; and

5) requirements for "**additionality**" that prioritize new interventions, e.g. for 'restoration', over existing traditional and place-based stewardship.

Time:

6) **rapid action**,

7) **time-bound targets** and

8) requirements for "**permanence**" that obscure the complex, dynamic and contested nature of social ecological change.

Finance:

9) "**financialization**", i.e. the design of interventions to serve the needs of large-scale finance to rapidly mobilize large-scale investments.

Knowledge:

10) the prioritization of **Western scientific knowledge** over traditional and place-based knowledge.

The purpose of identifying these ten dominant lenses is not to debate their importance or utility. Indeed to categorically denounce or exclude them would contradict the emphasis of the reverse gaze on expanding our vision and embracing diversity. Rather, identifying these lenses helps more systematically reveal multiple ways in which SMART targets exclude other actions that don't fit within them. That is, it helps reveal what else we might 'see' if we expand our gaze more broadly and inclusively.

The rest of the paper proceeds as follows. Section 2 addresses "What are we missing?" It draws on conceptions of relational natures to help create a broader vision of how people are currently caring for nature. Section 3 addresses "How do we capture it"? Drawing in part on the literature on digital ecologies, we ask what technologies might be repurposed to empower and 'count' a wider diversity of perspectives, knowledges and practices towards global goals, and how? It also asks what new types of data, including aggregated data, might this generate? Section 4 then considers "How do we get there?" We reconsider the ten dominant lenses that reinforce target-centric modes of governance, and ask what more dynamic (in time and space) approaches to human

nature relations might look like across scales. We ask, for the post-2030 KMGBF and beyond, how could global agendas more fully recognize, and support, place-based approaches? We then conclude with a summary of key findings and reflections on future directions for research and practice.

2. What are we missing? How are people caring for nature in place?

Reversing the global gaze requires embracing the heterogeneity of human-nature reactions that are missed through decontextualized, remote assessments of nature's status and condition. Yet calls for more contextual and relational approaches themselves encompass diverse worldviews, ranging from Western conceptions of 'social ecological systems' thinking to Indigenous cosmologies and other ontological approaches (Kimmerer, 2013; West et al., 2024). As articulated by West et al. (2024), recognizing and respecting this diversity requires not promoting any one particular worldview or ontology, but rather "walking together in a world of many worlds". Similarly Bartlett et al. (2012) speak of 'two-eyed seeing' as a metaphor for bridging scientific and local and Indigenous forms of knowledge. More generally, Cummings et al. (2023) call for "careful knowing" that grounds knowledge-making in community needs and understandings. Careful knowing, they argue, is critical to "epistemic justice" (i.e. the equitable and just use of knowledge). A more inclusive understanding of how nature is known and cared for, would likewise suggest that there are many areas, outside of formal protected areas and restoration projects, where nature is being protected or restored. The question remains, however, whether and how this diversity can be 'counted' towards higher level goals and targets.

The KMGBF aims to expand the diversity of conservation actions included in its 30x30 targets in part through the recognition of Other Effective Area-based Conservation Measures (OECMs) (Secretariat of the Convention on Biological Diversity, 2022). OECMs are defined as geographically defined areas, other than protected areas, that are governed and managed in ways that achieve positive and sustained long-term outcomes for conservation (Secretariat of the Convention on Biological Diversity, 2018). While in principle, OECMs allow the inclusion of community and indigenous territories, a recent study revealed that over 50% of existing OECMs are governed by governments and less than 2% by indigenous peoples and local communities (Jonas et al., 2024). At the same time, existing OECMs have been critiqued for not adequately meeting internationally agreed requirements. For example, Cook et al. (2025) found that <5% of existing OECM's have been assessed against the required criteria to qualify as OECMs, with 2.2% having features that contradict definition as OECMs. Even should both the designation and verification of OECMs accelerate significantly, these findings suggest that other actions are also needed to reverse the gaze and more fully recognize place-based approaches.

To date, efforts to map and count the collective contributions of place-based, relational approaches to nature recovery beyond formal conservation areas, have been very limited, and focused either on very rough estimates or on interventions with externally legible spatial boundaries. For example, it is estimated that Indigenous peoples own or manage more than a quarter of the Earth's surface area (Sze et al., 2021) including at least 37% of lands with low levels of ecological disturbance (Fernández-Llamazares et al., 2024). This provides some general indication that Indigenous peoples in aggregate play an important role in protecting and stewarding certain social ecological landscapes. However, Indigenous communities themselves are diverse and their social ecological relations much more complex than such standardized and aggregated data reflects (Bennett et al., 2023). Current global data also largely fails to capture the enduring and widespread protection and restoration of landscapes by actors, both traditional and non-traditional, whose actions lack externally recognized boundaries. It also excludes a wide diversity of more systemic actions, including struggles to reform land and tree tenure, whose effects may be more far-reaching, but diffuse and difficult to quantify (Benzeev et al., 2025). Meanwhile, the underlying drivers of degradation can be easily overlooked without qualitative analysis, and may not be addressed as part of conservation efforts, limiting long-term efficacy (Osborne et al., 2021). The end result is that existing global data sets represent only a small tip of the iceberg of the contributions of place-based approaches to respectful and reciprocal human-nature relations.

Indeed, the sheer number and diversity of ways in which individuals and communities are both formally and informally engaged in reciprocal relations with nature defies imagination, let alone quantification. Furthermore, conflicting approaches can be spatially overlapping, even before any normative evaluation of what's good or important is considered (e.g. national parks may contain closely mown lawns while 'unprotected' areas contain old growth forests and wildflower meadows). Place is a multi-scalar concept, with nested layers of identity (e.g., dwelling, settlement, region, nation) that typically do not correspond with the boundaries of ecological processes (Wedding et al., 2025), and may only partly correspond to governance jurisdictions (Wilbanks, 2015). Every human-nature interaction, from the installation of flowerboxes on a windowsill or birdfeeders in a home garden, to informal volunteer groups planting native species on public land, to farmers maintaining hedgerows, to Indigenous groups caring for land over hundreds or thousands of years, has social ecological significance. The dominant global gaze has also given significantly less attention to the 71% of the earth covered by ocean.

While many place-based activities may defy classification and quantification as a collective, there are a small but growing number of studies that provide some relative sense of scale. For example, one study in New Zealand found over "600 community environmental groups in the country engaged in restoring degraded sites and improving and protecting habitat for native species" (Peters et al., 2015, p. 179). This study also

classified and counted the key interventions these groups have engaged with in forests, streams and freshwater wetlands. In the county of Oxfordshire, UK alone, there are over 100 community action groups focused on climate and environmental action.[2] In South America, Jiménez-Aceituno et al. (2025) have identified 127 biocultural initiatives led by or collaborating Indigenous peoples and local communities in Ecuador, Peru and Colombia. While some of these approaches explicitly counter dominant regimes, including resisting the notion of 'the state' entirely (Nahuelpán et al., 2022), others harness, comply, or collaborate with the dominant gaze to greater or lesser extents and efficacy (Sangha et al., 2025). None of these examples encompass the work of institutions such as schools, businesses and managers of government property that may be contributing to nature recovery, even if it is not central to their mission. Such broadly directed actions are even more difficult to categorize.

Seen as a whole, this suggests that the majority of nature recovery activities are invisible through the ten dominant lenses of the global gaze (Box 1 above), particularly those contributions occurring outside of state-recognized interventions and guided by alternative worldviews. Natural science-based assessments of high priority areas are based on physical habitat and species characteristics, not the presence or absence of existing place-based actions and relations. The influential 'biodiversity hotspot' approach (Myers et al., 2000) exemplifies number-driven prioritisation that is often implemented inequitably or ineffectively (Smith and Matimele, 2025). Many place-based actions occur outside of biologically 'high priority' areas, or occur at a relatively small scale not considered significant to the global gaze. Protected areas are often located 'high and far', away from population centres and less connected to society (Joppa and Pfaff, 2009). Biodiversity or carbon credit markets (Lens 9) often require additionality (Lens 5), thus excluding a plethora of existing, place-based activities. In many regions in the Global South, place-based stewardship occurs in areas with limited tenure security and has no guarantee of permanence (Lens 8). In terms of duration, place-based conservation actions may range from ephemeral to ongoing over millennia. They are often informed by local knowledge, and frequently have not been subject to scientific study (Lens 2) (Alves-Pinto et al., 2021; Gurney et al., 2021). They also often have minimal dependence on private finance, and hence offer less opportunities for profit and control by external financiers (Lens 9). They may be difficult to quantify and hence tend not count towards externally defined, quantitative, time-bound targets. Yet while such place-based actions may be overlooked by the global gaze, they can be highly influential for conservation across scales, particularly taken in combination and considering all the innovation they bring.

[2] https://www.cagoxfordshire.org.uk

On the one hand, the very invisibility of place-based actions may play a key role in fostering experimentation, diversity and spontaneity, including enhanced agency for non-human actors (Tsing, 2015). Yet on the other hand, the often unrecognized nature of these activities can make them vulnerable and undermine their voice and recognition in larger-scale processes. For example, the UK's recent strategy for international development (UK, 2023, p. 22) aims to "...ensure UK bilateral ODA [Overseas Development Aid] becomes 'nature positive', aligning with the international goal to halt and reverse biodiversity loss by 2030, and the post 2020 Global Biodiversity Framework…". This suggests that UK overseas aid will prioritize projects that are recognized as aligning with the KMGBF. Meanwhile within the UK, Layard et al. (2024) studied the precarity of local wildlife sites. They found that even though local wildlife sites are a quasi-legal, and hence state-recognized, designation, they may fail to achieve even moderate protections of locally valued nature – even when such protection was feasible with minimal cost to the developer. Place-based contributions to nature recovery are also vulnerable to expropriation by the state to meet protected area targets, despite evidence that existing local efforts may be as or more effective for nature conservation (West et al., 2024).

The recognition that invisibility can produce such vulnerabilities, has led to calls to put more of these alternatively cared-for landscapes on the map (Brondízio et al., 2021). As 2030 beckons, resourcing may be even more tightly focused towards measures which count towards looming targets. As will be discussed in the following section, there is rapidly expanding interest in how new technologies might either help, or undermine, the empowering of placed-based efforts. We take this question one step further, and consider the potential role of new technologies in 'counting' these efforts towards global goals and targets.

3. How do we capture it? Repurposing technologies and making place-based contributions visible

Technologies are not power neutral (Lostanlen et al., 2025); they bear the hallmarks and legacies of the purposes for which they were created. The military origins of many conservation technologies, and in particular remote sensing via satellites or drones, brings a legacy of repressive use (Fish and Richardson, 2022; Haraway, 1988; Young et al., 2022). While these technologies have since been repurposed *into* conservation applications (Hahn et al., 2022; Lahoz-Monfort and Magrath, 2021), it is critical to consider how they are used *within* conservation. If used by external actors for security objectives, they may further concentrate power (Büscher and Fletcher, 2019; Duffy, 2016; Litfin, 1997) or stoke division within communities and other stakeholders (Simlai and Sandbrook, 2021). In this case, their deployment has simply shifted from military authorities overseeing civilians, to development and environment agencies, multi-

national corporations, large international NGOs, Global North ecologists and other more powerful actors overseeing less powerful actors living or working within the landscape (Mulero-Pázmány, 2021; Parris-Piper et al., 2023). Counter-hegemonic approaches to technology design, such as open source technologies, may have less inequitable histories, and may be more easily tailored to specific applications, but their use within conservation can still uphold power asymmetries (Hsing et al., 2024). Hence, while technologies can 'supercharge' conservation efforts and reconfigure how nature is seen and managed, their ethical, social, and cultural context must be accounted for and balanced to ensure equity of access and application (Lostanlen et al., 2025; Simlai and Sandbrook, 2021).

Reversing the gaze, therefore, calls for deliberately repurposing and 'democratizing' (Ford et al., 2021) technologies in ways that enhance equity and strengthen reciprocal human-nature relations. There is a growing body of literature that speaks to this aim by examining how existing technologies of surveillance and control are being repurposed by local actors to support and empower place-based approaches (Millner and Amador-Jimenez, 2025; Radjawali and Pye, 2017; Ryan, 2018; Simlai and Sandbrook, 2021; Turnbull et al., 2023). The emerging term 'pluriversal technologies' refers to such repurposing of tools and systems with the aim of "integrating diverse worldviews, knowledge systems and practices, emphasising co-design, co-production and co-ownership among all stakeholders, including marginalised and non-human entities." (Escobar, 2018; Friant et al., 2023; Haklay et al., 2022; Millner and Amador-Jimenez, 2025, p. 7).

Certain adaptations of technology facilitate such a pluriversal approach, including low price, low tech, easy to use, reparable, locally sourced and open sourced hardware and software (Haklay et al., 2022; Hsing et al., 2024; Millner and Amador-Jimenez, 2025; Mulero-Pázmány, 2021). For example, drones are cheaper and easier to use than other spatial technologies (Millner and Amador-Jimenez, 2025) and enable other viewing perspectives, while also producing visual and digital inputs that are relatively easily integrated into larger-scale decision-making (Boyle, 2023). Furthermore, drones present new opportunities for collaboration which may address or challenge existing tensions within communities (Muashekele et al., 2022). Drones thus "inhabit a zone of technological capacity whose political function is not yet fully decided (Millner, 2020, p. 2), with conflicting and contradictory uses in environmental, humanitarian, and security spheres that "give and take life, empower and oppress, and open up new potentials for justice, as well as enclose and control" (Fish and Richardson, 2022, p. 4).

The concept of 'counter-mapping' is increasingly used to describe how visual remote sensing technologies are being repurposed to shift power dynamics. Counter-mapping involves less powerful actors "…gaining access to the tools of the powerful… [and] using them to legitimize their claims to land and resources (Peluso, 1995, p. 400). Counter-

mapping may seek to create new maps, replace disputed maps, or integrate a more pluriversal approach into existing maps (Haklay et al., 2022). It may be applied by place-based actors to defend local rights and priorities (Chiaravalloti et al., 2022; Leao et al., 2014; Slough et al., 2021) or supported by external actors where scientific knowledge is limited, or where mapping unconventional aspects (often social, cultural, or phenomenological) is expected to improve the social-ecological outcomes of conservation projects (Fish, 2022; Millner, 2020; Paneque-Gálvez et al., 2014; Radjawali and Pye, 2017; Ryan, 2018). Growing trends towards counter-mapping reflect growth in mapping and spatial approaches more generally under powerful geotechnologies (St. Martin and Hall-Arber, 2008), with particular tools such as drones, satellite imagery, or GIS becoming more accessible to a wider range of users.

But the need for a reverse gaze goes well beyond counter-mapping. Technologies are rapidly changing the very nature of what is being seen, sensed and experienced, as well as how knowledge is generated, communicated and exchanged. For example, there is increasing use of digital sensors to detect air or water quality and monitor sound which may variously be used for remote surveillance or employed by place-based actors to care for place and strengthen social ecological relations (Paneque-Gálvez et al., 2014; Radjawali and Pye, 2017). Meanwhile, the use of eDNA, gene sequencing and gene editing technologies, expands the gaze at a micro scale. This micro-scale gaze, applied to soil and ice cores, extends the gaze over time and across millenia. Efforts to reverse the gaze of micro-sensing technologies can be seen in 'domesticated and democratised' bioscience (Meyer, 2013), 'indigenising' fungal biotechnologies (Perez et al., 2025), and genetic analyses in citizen science (Clarke et al., 2023). More broadly, the concept of 'extreme citizen science' refers to engaging place-based actors directly in co-creating the deployment of technologies that affect them (Chiaravalloti et al., 2022).

Concurrent with technological changes in measuring and monitoring nature, are changes in the construction of knowledge, communication and exchange about nature and human-nature relations. The use of digital media is expanding rapidly among people and across digital devices. These digital communications can be harnessed in ways that are either extractive or empowering and democratizing (Heikinheimo et al., 2020; Kottillil et al., 2025; Searle et al., 2023).

Taken together, the data that all digital technologies generate, in turn forms the cornerstone of machine learning and Artificial Intelligence (AI) that are rapidly changing the very nature and source of knowledge. And it is increasingly AI and machine learning that are becoming the remote actors driving technological innovation itself (Gama and Magistretti, 2025).

Simply repurposing these technologies, however, while it can lead to the generation of large quantities of locally relevant data, does not address how that data can then be

aggregated to inform, speak to, and be in dialogue with, global goals. Nor does it address whose responsibility, and at whose expense, such repurposing should occur. For example, Arora-Jonsson et al. (2016) critique the ways in which international environmental governance aims to create a 'global citizenry' that overtakes or replaces local place-based governance, and offloads the costs and responsibilities for monitoring and verification onto local populations. Thus it is critical to ask whether and how technology may aid in the development of more inclusive and representative measures of care for nature in ways that both: 1) re-aggregate diversified data collected according to local priorities, and in ways that are not constrained by the relatively narrow conceptions of space, time, finance and knowledge embedded in the current global gaze (Box 1 above) and 2) enable more inclusive global assessments of care towards nature that do not offload the costs and burdens of verification onto place-based actors. The use of technologies to re-aggregate or 're-globalize' in these ways is a critically important, but very under-studied, step in promoting more inclusive human-nature relations across scales.

The following Figure 1 provides a graphic representation that compares what may be currently counted as contributions towards KMGBF goals if viewed solely through the ten dominant lenses of global gaze (Box 1 above), with what more can be counted if we expand our gaze and, where appropriate, employ technologies for this purpose. The dominant gaze is represented by the top layer in the diagram, and shows a simplified landscape of formal protected and restored areas. The reverse gaze is shown in the lower layer and identifies a much greater diversity of nature recovery activities across a wider segment of the landscape. The "targets" heading lists the relevant KMGBF targets and the "reversed gaze" heading in the bottom right hand corner illustrates how the reversed gaze uncovers additional contributions relevant to the goals of the KMGBF targets.

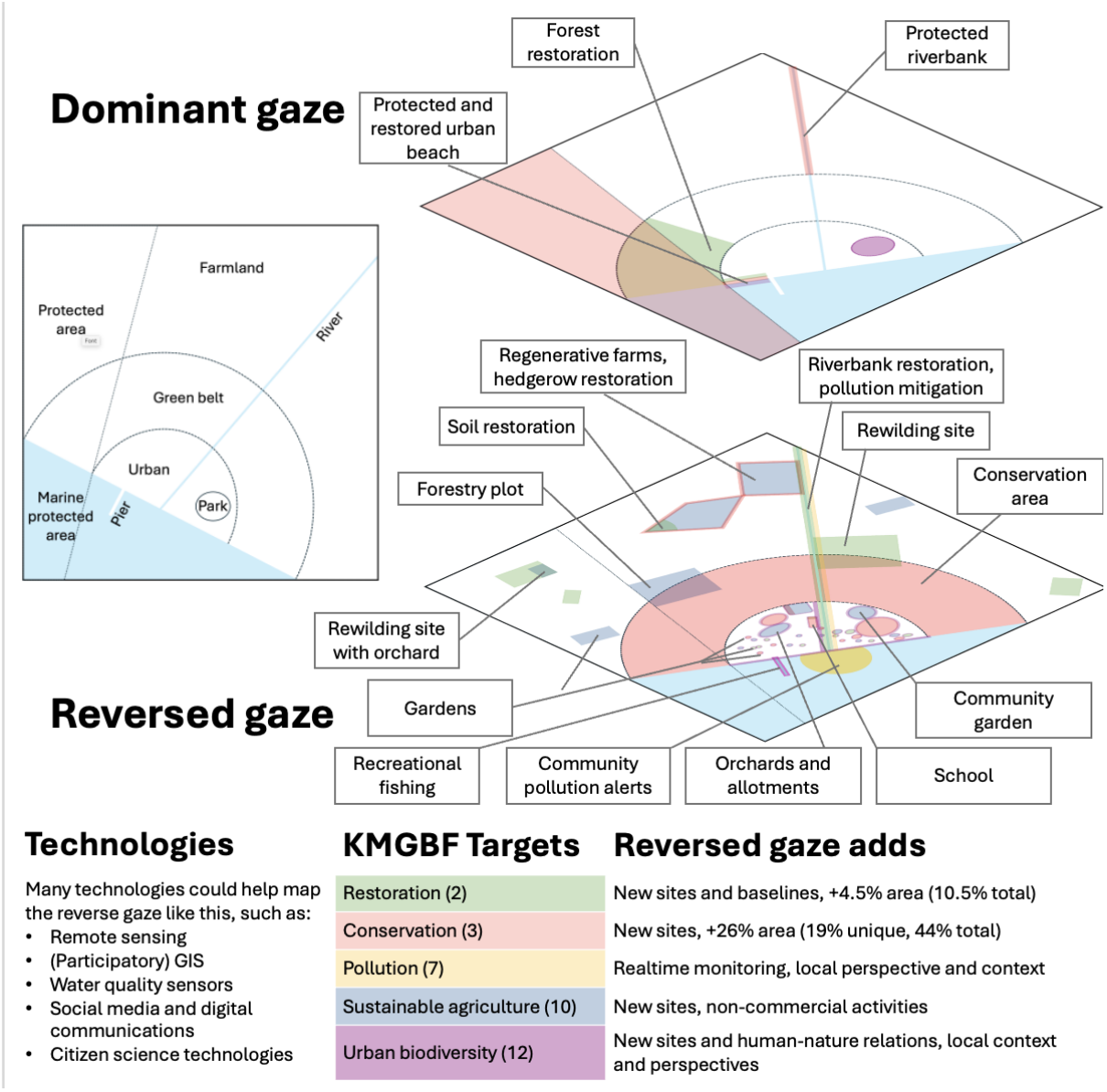


Figure 1: *How the reverse gaze might contribute to KMGBF targets in a hypothetical coastal town, including contributions to area-based targets, site identification, monitoring, and the re-evaluation of baselines. Source: Authors' own diagram*

There are an increasing range of initiatives that are beginning to realize these kinds of innovations in practice. Three boxes below provide case study examples. Box 2 explains how traditional knowledge holders expanded scientific understanding of sacred groves in Malabar, India, with hydrological models and geotechnologies acknowledging their strategic locations for Indigenous water management practices (Bhagyanathan and Dhayanithy, 2025). Box 3 details a seascape restoration map for Sanday, Scotland, wherein local knowledge was guided by ground-truthed drone surveys of seagrass meadows and participatory mapping to capture social practices and relations (Boyle, 2023). Box 4 considers the diverging results of two assessments of a proposed reservoir

development under the UK's Biodiversity Net Gain policy, one using remote sensing and another including in an situ survey (Parfitt, 2025).

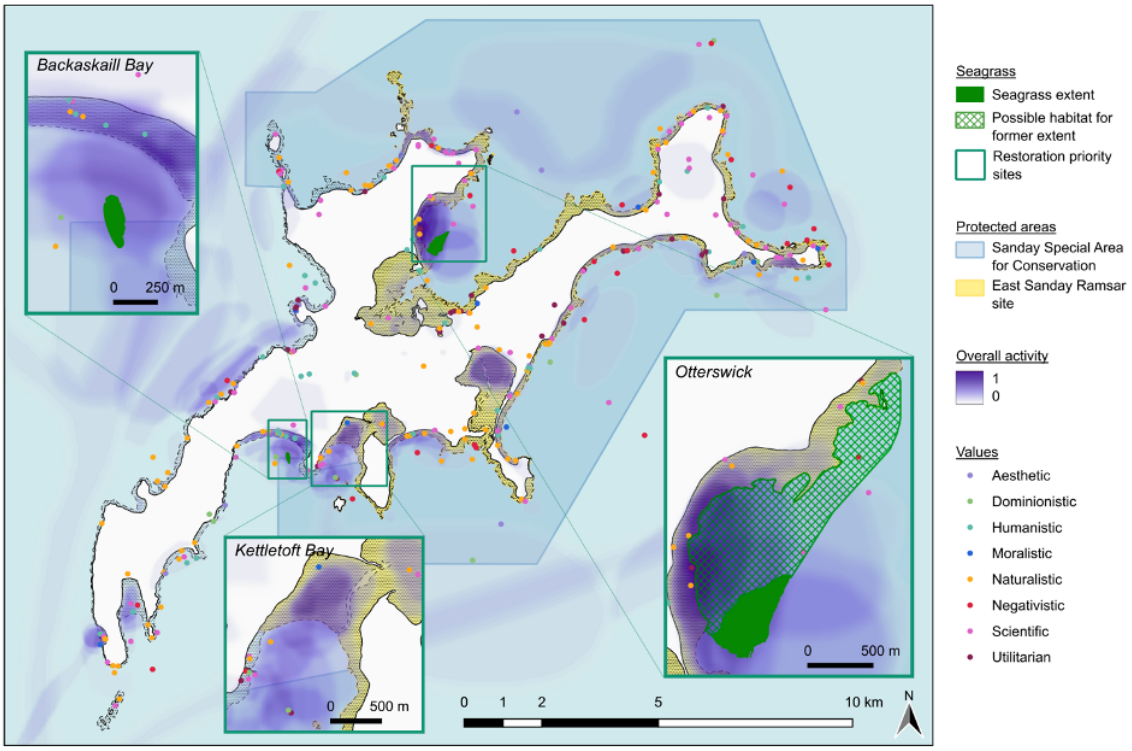
Box 2 Sacred groves and traditional knowledge in India's Malabar Coast

Bhagyanathan and Dhayanithy (2025) investigated the sacred groves of India's Malabar Coast through consulting ritual dancers and custodian elders, and then using GIS to analyse their spatial attributes with hydrological models. Though 44 groves were already known to science, interviews revealed another 332, and a further 16 were encountered during the fieldwork. Local knowledge holders were therefore aware of 7.5x more groves than were identified through external scientific assessments. The study also found these groves to be located strategically to reduce flooding and drought in a region of highly variable rainfall. Local idiom "kavu theendalle, kulam vattum", translates as "do not disturb the sacred grove, lest the ponds run dry" (Bhagyanathan and Dhayanithy, 2025: 607). These groves, though deliberately maintained by Indigenous peoples for generations, are only recently becoming known to the global gaze, leading to their recognition as 'nature-based solutions' and possibly their protection. Prior to this study, they had not been recognised beyond their local community as significant sites for conservation or hydrology. Through the use of qualitative and participatory approaches alongside geotechnologies, the knowledge of the sacred groves was therefore drastically increased, bringing to light characteristics which make them of value to the global gaze, and therefore adding to their worth in terms of resourcing and investigation.

Box 3 Co-produced seagrass mapping in Sanday, Scotland

Seagrass is a foundational habitat in many coastal social-ecological systems, though has been significantly degraded and frequently overlooked. Now a conservation priority across much of its past and present range, efforts to map seagrass distributions are underway but challenged by poor general awareness and difficulties in remote sensing through water columns, particularly in areas with poor water clarity or high winds. Sanday, in Scotland's Orkney Islands, had been modelled as a site of abundant seagrass populations, but initial surveys had not found any meadows, leaving distribution maps unclear (Thomson, 2014). Through transdisciplinary investigations led by local knowledge in an extremely challenging area for remote sensing, Boyle (2023) surveyed the coastline and found two undescribed meadows, which were then quantified through ground-truthed drone flights. The additional social components of this study also capture vital perspectives to build out place-based planning for restoration (Wedding et al., 2024). Through participatory mapping, in situ surveys, and remote sensing, this study reflects a reversed gaze which can be translated through maps to become intelligible to a global gaze.

Figure 2: Overall map of seagrass distributions, protected areas, activity heatmap, and values, with restoration priority sites (Boyle, 2023)



Box 4 Discrepancies in Biodiversity Net Gain seen among desk-based and in situ surveys, Oxfordshire, UK

Biodiversity Net Gain (BNG) is the UK government's approach to ensuring habitat loss from development is met with a greater offset, supporting overall improvement in habitat quantity and quality, and so (presumably) biodiversity. In 2024, the proposed development of the 150M m^3 South East Strategic Reservoir Option (SESRO) in Oxfordshire was assessed twice for its BNG implications, once remotely by the developer, and once by a local group using in situ surveys, with significant differences in biodiversity impact and legal compliance (Parfitt, 2025). Here, a global gaze finds that the SESRO development is positive for biodiversity, while a reversed gaze paints a different picture. The developer found the reservoir to increase BNG scores of 'area', 'hedgerow', and 'watercourse' habitats by 12.5%, 15.1%, and 32.9% respectively (meeting targets of ≥10% uplift). An alternative assessment involving place-based actors found that all habitats were predicted to decline (16.9%, 13.9%, 4.7%), thereby failing to meet BNG targets. The alternative assessment found that development-favourable assumptions, out-of-season surveys, unexplained reclassifications from prior developer reports, and missing or mismeasured habitats were primary drivers of these differences. The in situ study by place-based actors also identified 'irreplaceable habitats', a criterion also covered under the BNG, that included ancient, veteran, and notable trees (Nolan et al., 2020), and found 216 previously unrecorded individuals including species of national concern and specific sites associated with threatened roosting species. Such habitats and their indicator species cannot be observed remotely, reflecting a blindspot in the gaze-from-above where in situ observations are necessary, in this case supported by a reversed gaze. Table 1 below compares the methodologies and figures of the two assessments, with green shading reflecting figures which meet targets and red for figures which do not meet targets.

Table 1 Contrasting assessments of Biodiversity Net Gain (BNG)

Assessment	***Developer***	***Local group***
Methodology	*Desk-based remote sensing*	*Desk-based remote sensing, in situ surveys, historic data*
Area habitat	*+12.5%*	*-16.9%*
Hedgerow habitat	*+15.1%*	*-13.9%*
Watercourse habitat	*+32.9%*	*-4.7%*
Irreplaceable habitats lost	*Not assessed*	*216*

4. What should we be aiming for? What would a more dynamic (time and space) approach to governing nature recovery look like across scales?

In the previous sections we have discussed why broadening the global gaze is necessary to capture contributions to nature recovery that are otherwise missed, and how technologies can be repurposed to variously empower more diverse actors and produce data relevant to a global gaze. Yet to more fully expand the realm of the possible in human-nature recovery, and transform power inequalities (Osborne et al., 2021), it is necessary to look beyond the generation of data and technology, and address core drivers of biodiversity loss and nature's decline, including those identified by IPBES as key to transformative change (O'Brien et al., 2025), i.e. disconnection from nature, the concentration of wealth and power, focus on short-term and material gain. Without addressing these drivers, both global targets and technological innovation will remain highly susceptible to co-optation by powerful actors, while profit incentives may override concern for nature, including the social ecological effects of energy and resource intensive technologies (Turnbull et al., 2023).

To thus expand our gaze in a holistic sense, it is helpful to revisit and rethink the dominant conceptions of space, time, finance and knowledge that are embedded in the ten lenses of the global gaze (see Box 1 above). Firstly, the emphasis of Lens 1 on "scaling up" from a reverse gaze perspective, might be reimagined to include "scaling out" and "scaling deep" (e.g. O'Brien et al., 2025; Pienkowski et al., 2024; Wang et al., 2025). While "scaling up" refers to widespread replication of a standard, model or blueprint intervention, "scaling out" emphasizes horizontal learning between placed-based approaches and voluntary and selective local adoption of innovations tailored to local contexts. "Scaling deep", in turn, refers to deep changes in attitudes, norms, knowledge and values and structural transformations (Pienkowski et al., 2024, p. 1806).

The current focus on fixed area-based targets (Lens 2) could be expanded to prioritize sites of 'everyday nature' and other areas of social, economic and cultural significance, that are cared for by place-based actors, regardless of their current legal status (Lens 3). These valued places, and the human-nature relations embedded in them, would be recognized as inherently neither fungible nor tradable (Lens 4). The fact that these valued places are already being cared for by place-based actors, and in many cases may have been protected by place-based actors for years, decades or centuries and hence are not 'additional' (Lens 5), would enhance their value in reaching global goals.

Regarding rethinking time, an expanded gaze would not only consider issues of speed and urgency (Lens 6), but also respect the relevance of a wide range of time-scales. Both speed and scale might be more broadly reconceptualized in terms of the social salience

and durability of social relations and conservation action, rather than solely in terms of state-based, long-term designation of protected areas within fixed boundaries. Rather than focus primarily on time-bound targets, the time-frames of relevance would be adjusted to suit particular social, ecological and political contexts. In this way, rather than focusing only on actions that promise 'permanence' (Lens 8), there would be recognition of the importance of all time-frames, from ephemeral actions that nevertheless support positive human-nature relations to the commitments of some Indigenous and local communities to particular places over millenia.

If we thus expand our conceptions of space and time in ways that are more socially and ecologically inclusive and equitable, this also requires new approaches to funding nature recovery (Stanley et al., in process). The global gaze emphasizes nature's financialization and commodification (Lens 9) and the internalizing of environmental harms and benefits into existing, and highly unequal, systems of global trade and capital accumulation in order to capture a share of the trillions of dollars circulating in these markets (Ranger et al., 2023). Simultaneously, the reverse gaze reveals the potential for self-sufficient, place-based approaches relatively independent of the politically and economically volatile global market, and better capable of accommodating alternative, place-based knowledge systems (Haklay et al., 2022). As argued by Wedding et al. (2024, in press) and others, effective community engagement and co-production supports stable interventions, more relevant to the timescales of ecosystems and arguably less vulnerable to political shifts. Such relatively stable interventions are also critical to building epistemic trust and transparency (Skarlatidou et al., 2024). At the same time, it is important to pay heed to how the concentration of wealth reinforces concentration of power. This means that nature interventions must take care to avoid reinforcing extreme wealth inequalities that give certain individuals and corporations outsized influence over governance decisions (Adams, 2017). As argued by INCITE! (2020), 'the revolution will not be funded', meaning that transformative change of the kind articulated by IPBES (O'Brien et al., 2025) is unlikely to be financed by those who benefit most from the status quo.

Finally, in terms of the nature of knowledge, and the associated technologies of knowledge generation, a reverse gaze calls for recognizing the contribution of a much wider diversity of knowledge than that captured through quantitative scientific method alone (Lens 10). This includes not only the wisdoms of Indigenous and traditional knowledge, but also place-based and situational experience more generally. This is also where the repurposing of technologies, as discussed in Section 3 above, plays a key enabling role. Indeed, if we are to better recognize, and where necessary measure, count and support, the contribution of more diverse forms of human-nature relations to global goals, it will be necessary to find new and innovative ways to capture and aggregate highly diversified data and knowledge. This involves in part drawing on the power of the

many to generate such relevant data in ways that are beneficial to their efforts. But wherever this is not feasible, or entails undue burden on place-based actors, it may also require new approaches to remote, global-scale assessments that assess large-scale trends across a pluriverse of initiatives.

Drawing on these reflections, Table 2 below summarizes how a reverse gaze might help expand our vision beyond the narrowing lenses of the dominant global gaze. Note the emphasis here is on expanding our vision, rather than necessarily replacing existing efforts.

Table 2 Reversing and expanding the gaze

	A narrow global gaze	**A reversed and expanded gaze**
I. Space	1) **Scaling up:** emphasis on expansive scaling of standardized interventions	Focus on 'scaling out' through horizontal learning about a pluriverse of approaches and 'scaling deep' through new ways of thinking, valuing and experiencing.
	2) **Area-based targets:** Focus on protected areas through the prioritization of 'high biodiversity' hotspots based on natural science assessments of biodiversity.	Priority areas include places already cared for, including sites of 'everyday nature' and other areas of social, economic and cultural significance.
	3) **State-based legality:** Focus on protected areas (and OECMs) as percent of habitat types	Focus on biodiversity and ecosystem health across entire landscapes, beyond legal and formal protected area designations and including processes like relational commons.
	4) **Fungibility:** Ecosystems and their contributions are treated as not location-specific and can be moved, traded, or substituted[3]	Ecosystems are viewed as embedded in particular places and social ecological relations.
	5) **Additionality:** Focus on additionality, e.g. designating and protecting new areas, sequestering additional carbon.	Emphasis on extent and condition of existing natural stewardship and supporting and expanding it.
II. Time	**6) Speed:** Emphasis on rapid uptake of standardized interventions.	Emphasis on support for existing place-based approaches and a wide range of time-scales, including long-term commitment to place. Speed and scale are reconceptualized in terms of social salience and durability of social relations and conservation actions.
	7) **Time-boundedness:** Focus on time-bound targets.	Time-frames adapted to suit different social, political, and ecological contexts[4]

[3] (Kalliolevo et al., 2021)

[4] (Mace et al., 2010)

	8) **Permanence:** Emphasis on de jure long-term permanence as defined by dominant state and private institutions.	Inclusive of all time-frames, from ephemeral to long-term, including recognising diverse informal and formal governance structures and their relevant temporalities.
III. Finance	9) **Financialization:** Focus on large-scale finance by external actors to achieve speed and scale as defined by global actors, including incentivizing the private sector through opportunities for capital accumulation[5]	Emphasis on self-sustaining efforts, with minimal dependence on external finance, as well as on wealth redistribution.[6]
IV. Knowledge (and Technology)	10) **Scientific knowledge & quantification:** Scientific knowledge production to meet an ever-expanding list of national reporting requirements based on globally standardized units and aggregated data.	Emphasis on measuring existing contributions. This includes drawing on the power of the many through empowering forms of repurposed technologies, 'extreme citizen science'[7] and place-based engagement and the aggregation of disaggregated data. It also includes a repurposing of a global-scale gaze through new uses of technology for assessing larger-scale trends across a pluriverse of initiatives.

In sum, there are many alternative approaches, beyond target-centrism, that can facilitate the effective and equitable multi-level governance of human nature relations. Much more dialogue and creative thinking are needed if we are to better achieve the potential of a reverse gaze and catalyze deeper human-nature transformations.

5. Conclusion

A growing sense of urgency over climate change, biodiversity loss and the need for nature recovery has contributed to an explosion of new technologies for measuring progress towards an ever-increasing number of global targets. This has driven, and been driven by, a 'global gaze' based on particular notions of space, time and human-nature relations that narrow the vision of what counts as positive change, thereby missing a much wider

[5] (Coad et al., 2019)

[6] (Adams, 2017; INCITE! Women of Color Against Violence, 2020)

[7] (Chiaravalloti et al., 2022)

pluriverse of relevant people, places and actions. Yet at the same time many of the same technologies that are serving this narrow global gaze hold potential to be repurposed to recognize local, place-based and relational approaches to nature recovery. While there is a large and growing body of literature that speaks to repurposing technologies, there has been a relative lack of engagement with whether and how such a repurposing could, or should, also be used to directly speak to, and inform, global-scale targets and decision-making. We argue that such a two-way process, of both repurposing tools to make them more inclusive and also, where appropriate, translating them into forms readily visible to globally dominant actors is, while fraught with its own risks, critical to transform the power dynamics of nature recovery and open up the realm of the possible.

This paper has employed the concept of a "reverse gaze" to consider 1) what is missing in the global gaze of relevance to global targets, 2) how technologies might be repurposed to better capture and count a wider pluriverse of place-based contributions to nature recovery and 3) how multi-level governance itself might evolve to transform human nature relations. We have used the KMGBF as a reference point for this analysis, considering both its well-known 30x30 targets for biodiversity protection and restoration, as well as its commitment to inclusive and participatory approaches.

In Section 1 we have identified how the requirement for targets to be SMART, while they may play a critical role in holding powerful actors to account, also risk limiting what is recognized as nature recovery. They do this through a series of filters or lenses (Box 1 above). These include: an emphasis on the scaling up of standardized approaches at rapid speed through area-based targets, emphasis on formalization and legalization, fungibility and additionality. Likewise they emphasize time-bound targets and permanence that overlooks a plethora of other contributions operating under very different, but often place-appropriate time scales. These narrowing lenses in turn contribute to narrow conceptions of finance that emphasize financialization, i.e. the design of conservation to serve the needs of large-scale finance based on unequal capital accumulation. Finally, the emphasis on quantified targets favors Western science and technological tools of 'surveillance' rather than the integration of other forms of knowledge and data and the repurposing of technologies to empower place-based approaches.

In Section 2 we address how disproportionate emphasis on target-centric governance excludes from view a pluriverse of other approaches to nature recovery that don't fit within its scope. Building off of this analysis, Section 3 provides a conceptual road map for how a repurposing of technologies can expand the range of what is visible and sensed, and how this can variously be used to reinforce the global gaze or to empower a reverse gaze. Figure 1 then provides an abstract example of a landscape and compares and contrasts what can be seen or sensed through a global gaze versus a reverse gaze, and then estimates what this might mean, quantitatively, in terms of meeting select KMGBF

targets. Finally Section 3 reflects on how target-centric governance itself needs to change, as summarized in Table 2, in order to open space for alternative conceptions of time, space, finance and knowledge and associated broader conceptions of positive human-nature relations.

In sum, this paper provides a multi-faceted conceptual road map regarding what it would mean to reverse the gaze, transform multi-level governance and open up the realm of the possible for human nature relations. This road map also serves as a call for much more research and thinking to consider the potential for new technologies and new governance mechanisms to further reverse the gaze, while also providing the data needed to inform higher-level coordination to address global challenges. Post-2030, a reversed gaze has significant contributions to make towards whatever global targets and ambitions come next, aligned with the 2050 CBD goals. We hope that perspectives such as this can ensure the vision of such goals continues to broaden, rather than narrow, with each iteration. Such a combination of diversifying the vision, while also communicating effectively across scales, is necessary to recognize and empower approaches that are both grounded in care for place, yet also multi-scalar, dynamic and responsive to ever-changing human nature relations.

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