The politics of influence in biodiversity offsetting

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Preface

Biodiversity offsetting has become a cornerstone of environmental policy since the 1990s, to counterbalance the habitat lost to a development project by conserving equivalent lands elsewhere. This article reviews how actors interpret, shape, and contest offsetting policies, placing emphasis on governance and politics rather than the most commonly explored technical design and implementation issues. It highlights the manifold discursive, legal, resource-driven, and capacity-building strategies that stakeholders use to influence offsetting processes and outcomes. On this basis we state future directions for social science research and policy making.

Introduction

Offsetting has become a cornerstone environmental policy strategy to counterbalance the habitat lost to a development project by conserving equivalent lands elsewhere, as the last step in the mitigation hierarchy. Since the 1990s, offsetting policies and programs have increased in number and types around the world, with research on their design and effectiveness growing in parallel. Scholarly work on offsetting has explored how to bring more data, stronger models, and precise metrics into the design and implementation of offset regulations. Although important, these analyses fail to explain how an abstract idea like offsetting is translated into practical rules and regulations, a process that is deeply social and political. After all, the idea of offsetting is born out of a compromise between the economy and the environment. Hence, effective offset governance requires getting both politics and science right. Issues of data, models, and scientific expertise must be considered alongside deliberations over values, goals, and tradeoffs. Throughout the policy process, it is important to understand efforts of interested actors to influence the goals, laws, and practices of offsetting as a condition to build more sustainable offset policies.

In this review article, we examine the means used to influence offset policies and discuss how related strategies affect policy outcomes. Specifically, we ask: how do different actors exert influence on offset policy? And how does this competition over policy goals and mechanisms complicate the governance of offset programs? To answer these questions, we use the policy stages framework[1] to highlight how stakeholders affect offset policies at different stages, what they hope to achieve, and the implication for effective environmental governance. For each policy stage, we identify who exerts influence, on what policy aspect, and what channels of influence are used to exert influence (Fig. 1).

We synthesize existing knowledge about how offset policies come to be actualized through the influence of multiple actors including professional unions, environmental networks, and administrations, as well as land developers, environmental consultants, scientists, landowners, environmental NGOs, investors, and other financial actors. Directly or indirectly, these actors shape offsetting interpretations and rules and influence policy outcomes. We also examine the different objects of influence, i.e., what parts of the policy arrangement do actors target to align with their interests, and how.

Actors may concentrate their efforts on specific bits of the policy process, such as the public meaning of offsetting or more specifically the formal and informal rules governing implementation. Actors might want to see a specific issue represented in policy debate, may wish for a rule to be clarified, strengthened, or undermined, or wish for a favorable interpretation of rules during implementation. Finally, we investigate the actors' channels of influence, i.e. the formal or informal means and resources that actors mobilize to exert their influence and reach their goals, such as lobbying, litigation, public advocacy, discretionary relations, and *ad hoc* negotiations. In adopting a fuller view of how actors influence offsetting throughout the policy process, we build on existing social scientific research such as offset discourses[2] or metrics[3], and recognize that some parts of offset governance can be inherited from earlier environmental policies while other components be constructed specifically to promote offsetting[4].

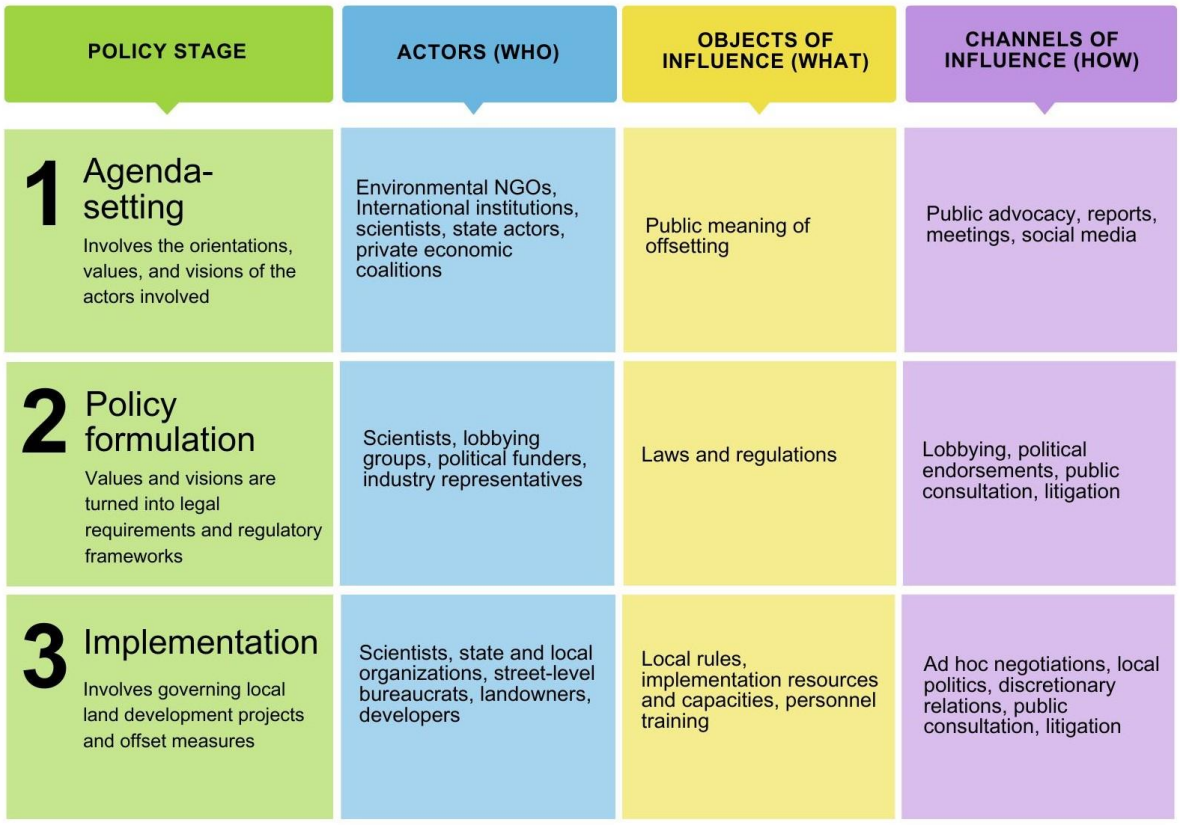

Fig. 1: The policy stages framework to understand influence in biodiversity offsetting

Description: Fig. 1 illustrates the main actors, objects, and channels of influence in the agenda-setting, formulation and implementation stages of biodiversity offsetting. It reflects the diversity of actors involved

in biodiversity offsetting and their manifold discursive, legal, resource-driven, and capacity-building strategies employed to shape policy processes and outcomes.

Overall, we shed light on the variety of actors and influence strategies that shape offset policies across different geographies, scales, and contexts, as well as on key blind spots in the extant literature that require further research. We conclude that it is important for the policy process to be open to influence by different interests and actors because this ensures that policies are responsive to stakeholder needs, but it is also important to protect the policy process from the over-expression of narrow private interests that overshadow broader public considerations.

Setting the offsets agenda

As the first step of the policy cycle, the setting stage refers to the moment when a problem is acknowledged as a public one that requires government intervention, thereby becoming the focus of debates and controversies about the definition of the problem and about the relevant policies to address the problem [5]. What is at stake during this stage is the public understanding of offsetting, i.e., what is meant by offsetting, what should it achieve in terms of public goods, and what is a relevant institutional logic for its administration. As it takes place at broad national or international levels, stakeholders are mainly organization representatives, acting on behalf of collective interests, such as regulators, NGOs, research institutions, local communities and professional unions.

The object of influence at this stage is twofold: the relation between mitigation and offsets in the context of debates about “the inevitability of development” and the institutional mechanisms to supply offsets to land developers. First, the meaning of offsetting has evolved contextually and over time [2,6–9]. Historically, governments have relied on creating protected areas and limiting construction on ecological hotspots to protect biodiversity but such policies are limited by funding and intensifying pressure to open lands for development and agriculture. Promoters, including economic coalitions as well as public institutions such as the European Commission, and large environmental NGOs such as the IUCN have progressively framed the need for offsetting against the assumption that development is a public necessity and inevitably at least some of this development will harm biodiversity [10,11], justifying the need for

offsetting, the last step of the mitigation hierarchy, as a compromise between development and conservation. Though it is often criticized for its weak ecological results on the ground, the idea of offsets as part of mitigation steps is now well spread and adopted in more than 100 jurisdictions around the world [12,13].

Second, the principles and institutional mechanisms for organizing offsetting are also up for debate within institutional arenas. This is a question of how to get developers to do offsetting (voluntary or regulatory) and how or who will oversee the offsets (a market-based credit system or the internalization of offset production by land developers). These concerns are discussed differently among different stakeholders. For public sector actors, the main policy instrument is regulation, and offsetting enters in so far as it is a mechanism to help enforce regulations more effectively while also providing flexibility in compliance [14–16]. For industry coalitions, offsetting is better defined as a voluntary contribution that businesses would make to enhance their reputations and generate a social license to operate, while also creating a necessary private conservation investment stream that could be critical in a time of high government debt [17]. According to Damien's et al. [2], in the last decade, the regulatory interpretation of offsetting has paved way to the more voluntary and private-sector led agenda for biodiversity offsetting.

This discursive shift is partly reflected in the uptick in new alliances in conservation. Partnerships between environmental NGOs and the private sector – what Apostolopoulou [18] calls a "symbiotic relationship" – has shifted a focus from a command-and-control approach where regulators define no-go territories to a more flexible approach where third parties (NGOs and private corporations) provide conservation services as a condition to overcome previous restrictions. For some NGOs, such framing promises new funding for conservation, often spoken in terms of bridging the "finance gap" [19,20]. Especially in the international context, the funding is also seen as a mechanism for improving local livelihoods [21]. The Forest Trends' Business and Biodiversity Offsets Program (BBOP) is one example of a symbiotic relationship that has arguably done more than any organization to promote offsetting to businesses. In the USA, organizations such as the Environmental Defense Fund (EDF) and The Nature Conservancy (TNC) play a similar role.

However, not all actors and stakeholders are equally positioned to influence the agenda around offsetting. Particularly in cases where the offsets are paid for by developed country actors and produced in developing countries, for example under the Clean Development Mechanism or the REDD+ program of the UN Climate Change Convention as in the case of climate governance, scholars worry that local communities are left out of the discursive framings [22,23]. Communities can, to some extent, support or contest offsetting by accepting or denying legitimacy to ideas, but as many scholars note rural communities in developing countries find it relatively harder to shape the agenda, often making them vulnerable to loss of access and/or displacement[15].

More recently, offset advocates, especially environmental scientists, confront the increasing evidence that offsetting programs are fledgling if not outright failing [24–26]. One important response has been to frame the problem in terms of inefficiency and accountability [3,27]. In this regard, and as noted earlier, scholars argue for a need to standardize metrics [24,28], have better targets[29], include broader ecosystemic indicators, and more public information [30,31]. The framing around accountability, however, is critiqued for reducing a complex institutional challenge into a technocratic accounting problem [32].

Science plays an important role in legitimizing various conceptions of offsetting, but science is itself an important space for exercising influence. Ecological concepts such as "ecosystem services" and policy objectives such as "No-Net Loss" (NNL) of biodiversity represent a specific conception of nature, where nature is quantifiable and substitutable. Recent concepts such as "Net Gain" [33], "Nature Positive" [34], or "Nature-based Solutions"[35] frame offsetting not only as a mitigation but as a conservation and adaptation strategy. Influence also plays out in science-policy organizations such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) which recently promoted offsetting as a useful example of policy innovation [36]. While concerns about ecological efficacy are recognized and complicate public interest, the solution has sometimes been to replace older terminologies and their associated concerns with new terms such as biodiversity credits, habitat banking, or biobanking [37,38]. New terminologies and buzzwords can mask the failures, while future possibilities are promoted, creating false promises [39].

Advancing stronger mitigation policies requires a more careful analysis of how actors influence the offset discourse to their advantage. Participation in institutional arenas, coalition funding, social media, report writing as well as scientific publications and conferences constitute the main means of influencing the offsetting discourse. However, at this stage, influence is hard to study empirically because the object of influence is highly discursive and subject to change. Consequently, these influence channels are poorly documented in the literature. Thus, more empirical work is needed to understand the contestations over the public meaning of offsetting and to examine how these discourses hinder or enable effective mitigation. Science and modeling are part of developing such an understanding, but the documented practical challenges of formulating and implementing offset policies need also to inform agenda-setting. This requires complementing the channels of scientific discourse with inputs from other actors including social scientists, NGOs, and even contrarian activist communities. To advance effective policymaking, the public debate must be made more open to science but also to critical perspectives.

Formulating offset policy

Once on the national agenda, public problems become institutionalized through legislation. The role of legislation is different for voluntary- and compliance-based offsetting. For voluntary offsets, the government tends to have a limited role and trans-national forums such as BBOP have been more influential. However, as mentioned earlier, voluntary programs comprise a small share of total offsets, underscoring the importance of engaging state power in their governance. Compliance-based offsetting, in contrast, involves a range of national actors, particularly elected officials and regulators, and many different points of interaction such as committees, consultations, and hearings. At the agenda-setting stage, the public meaning of offsetting is rendered into specific policy goals that are then deliberated and finalized. Goals inform laws, regulations, and programs, tied to dedicated resources. While the passing of a law is a major outcome of policy formulation, laws are themselves continuously revisited and reformulated, developed into additional regulations such as decrees and guidelines, making this a long and continuous process. Here again, organizational representatives are involved in the process, promoting their visions and interests. Professional unions are important vehicles for lobby and influence and researchers are also involved as experts in policy-making. To some extent, individual actors who benefit from a strong

reputation or visibility such as specific scientists or NGOs can also be consulted for their own experience.

The literature highlights that stakeholders and individual actors compete to influence two particular aspects of the policy formulation: 1) the scope of the policy, including what type of biodiversity is protected, what types or sizes of projects are regulated, and who is liable for carrying out the offsetting activity and 2) actions required of the permittee to achieve compliance. Decisions on issues of scope and compliance requirements are important to economic developers as well as to conservation outcomes.

First, the scope of the policy refers to what counts as an impact needing mitigation. Some countries like the USA regulate based on impacts on endangered species, others like France and Brazil regulate based on impacts on ecosystems and habitats, and still others such as Australia regulate offsetting based on species at the national level and habitats at the state level[4,40,41]. In either case, stakeholders influence what is considered biodiversity, or what is considered an ecosystem to be preserved or managed for improvement, with a key scientific debate centered on whether regulations apply to species, habitats, or ecosystem functions and services. Political struggles aim to expand or contract the scope of the law and thus the scope of offsetting. In the USA, actors jostle to influence what species are included or excluded from protected lists whereas in France, with habitat as the object of assessment, stakeholders have greater leeway in evaluating what is of broader ecosystemic value on the site [42–44]. While in theory, these are meant to be technical decisions, there is considerable interpretative work required in applying so-called “best-available science” to specific contexts [45]. For example, in the USA, Lowel and Kelly [46] note that when listing species, the National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service tends to adhere more closely to scientific criteria than the Fish and Wildlife Service (FWS). Stakeholders also seek different regulatory treatment based on the content or shape of the projects, sometimes even negotiating for different nodal agencies. In many countries, projects under a certain threshold are treated differently to minimize administrative work[47–49]. Industries and environmental groups lobby to raise or reduce these thresholds. Certain sectors may be given regulatory exemptions based on public interest and when formulating policies, companies seek to have their sectors considered in these exemptions. The scope of

the policy is an important object of influence whose political dimension deserves to be asserted more clearly. It is a discrete but important site, particularly vulnerable to economic expressions. Science underpins these decisions, but a lack of clear consensus or agreements about models and evidence means that the policy scope is ultimately politically negotiated.

Second, actors look to influence the rules and regulations determining what constitutes compliance with mitigation requirements. Before regulators may allow for offsetting as a compliance strategy, they must determine whether the permittee has taken efforts to avoid and reduce the total impact [47]. This is an important space for negotiation because what is considered reasonable effort to avoid and mitigate can differ from context to context, though law and precedent create guiding rules and norms [50,51]. Once size and scope of impact is ascertained, what the permittee needs to do to mitigate the residual impacts also requires governing rules. The NNL principle is the commonly used reference in organizing this relationship between loss and gain, but as scholars note, putting the NNL principle into practice is complicated [52,53]. In fact, in the USA, the NNL idea has been hotly debated [54]. In 2016 FWS outlined a mitigation policy rooted in the principle of Net-Gain, one step ahead of NNL, but soon after the change in US presidential leadership, the rule was withdrawn. In other countries such as Spain [55], UK [56] and China [57], we find the expansion and contraction of mitigation rules tracking political shifts.

Another important component of compliance relates to the engagement with market forces. Much of the current compliance offsets are non-market-based where the permittee is liable for producing necessary levels of habitat conservation or restoration [58]. In some countries, like the USA, Germany, and Australia, regulators and NGOs have pushed for market-based approaches where permittees can buy environmental credits from a regulated ecosystem service seller. In a smaller number of cases, regulators allow permittees to pay compensation that then funds a public agency or non-profit organization engaged in conservation activities. Questions of habitat equivalency, additionality, and long-term protection, critically important to achieving no-net loss, are also subject to debate[59]. In this regard, scholars highlight a recent tendency toward offering greater flexibility within national policy frameworks[60,61] such as looser equivalence between impacts and gains or limited specification of assessment methods. This reflects a tension between offering flexibility to facilitate implementation

on one side and enforcing strict standards and protocols on the other side[62]. Decisions over these rules allow for influence games and negotiations during implementation stages[63].

Actors use two main channels for influencing policy formulation: legislative debate and litigation, besides also relying on behind-the-scenes negotiations that are difficult to study empirically. First, during policy and legislative debates, stakeholder coalitions look to enshrine their conceptions of economic development and environmental conservation [64,65]. Industries, organized into blocs and associations, work collectively to promote their interests at the federal or national levels. For instance, the National Environmental Banking Association, the lobby representative of various offsetting interests in the USA, has pushed for more consistent rules to reduce uncertainties and level the playing field [66]. Similarly in France, the mining industry participates in multiple working groups under the auspices of the Ministry of Ecology to put forth their views on how offsetting should be integrated into mining projects. Public hearings and consultation processes are another institutionalized channel for stakeholders to express their positions about offsets and how they should be integrated in broader environmental acts [9]. As is the case with lobbying in other contexts, one can expect that lobbying influence is highly dependent on the level of financial and political clout of these associations.

Second, actors influence policy formulation through litigation. Both industry groups seeking deregulation and environmental groups seeking more protections rely on litigation to influence policy. This channel can influence both the scope of policies such as what species should be listed as well as the requirements around what should constitute mitigation and offsetting. For instance, in the USA, petitions to add or remove species from the endangerment lists directly affect offsetting policies for the species [67]. While this is observable in the USA, other countries favor political debate and advocacy to transform policy scope (as is the case in the example of ecosystem services above). A more widely spread use of litigation lies at the project-level (see next section).

Science features prominently in the politics of policy formulation. Unlike in agenda setting where science is open and not formalized, the involvement of science in policy formulation is more explicit. For example, science is important when determining the level of endangerment of a species or the specific ways to mitigate impacts [68]. Scientific

determinations are produced through expert bodies, datasets, maps, and assessment reports, all of which present opportunities for interested actors to influence decision-making. Actors may also insist on specific scientists to be on expert committees or advocate for the use of certain kinds of models and datasets. Because of the many ways to produce and engage science, potentially leading to the instrumentalization of knowledge for the sake of private interests, entrusting more public institutions with science and knowledge production is an important means to undermine detrimental private influence.

The politics of influencing policy design is better understood than the politics of agenda setting. However, critical blind spots remain. Much of the literature has focused on offset policy design, with less analysis of how actors vie to influence laws and rules that indirectly but profoundly affect mitigation policies. The specific channels of influence and the unevenness of different social groups to control these channels are also poorly understood. While there is work on the power of corporate influence [9], how NGOs and other civil society organizations try to influence offset laws and their ability to achieve their goals would benefit from deeper research. Such analysis of the formal policy-making process can help design offset laws that are geared toward effectively producing environmental public goods.

Implementing offsets

Implementation of an offsetting program is not just a straightforward process of mechanically applying rules but implies negotiating and improvising enforcement in context specific conditions. This can involve a vast array of actors, technologies, and systems that go beyond the regulatory agency or the permittee. This includes environmental consultants, conservation providers (both for profit and non-profit conservation activities), scientists, financial organizations, property management groups (like land trusts), landowners, farmers, communities, and standard developers[69,70]. It is also important to recognize the critical role street-level bureaucrats play in designing and coordinating localized offset programs in their jurisdiction[68]. Given the limitations of implementation resources [71], regulators often outsource important responsibilities such as monitoring, standardizations, safeguards, and other checks to NGOs or third-party private actors [72,73]. Because these actors have skin in the game, they too seek to influence implementation in ways that strengthen their

positions[74]. As the size of the offset programs expands, this range of actors also grows, further expanding the influence possibilities.

At the land development project level, actors look to influence the local rules and decisions, including various elements of the administration such as agency authority, resources, and personnel, as well as the formal and informal localized rules for what counts as an impact and an offset. For developers facing regulations, the opportunity to negotiate compliance requirements starts at the environmental impact assessment stage, far before a discussion about offsetting [75]. As evidence of some impact becomes clear, actors might negotiate for the precise assessment criterion that could minimize their compliance costs and delays. Such negotiations about metrics and indicators are found to be critical spaces for weakening or strengthening policies [76]. Given the determination of impact, the mitigation measures are also negotiated, both formally through documented applications as well as informally through conversations in person and over the phone. What is negotiated is the scope of the mitigation, the ecological responsibilities at the offset site, timelines, and costs. Empirical evidence in France clearly shows that the ecological outcomes of restored sites are inferior to the preservation of original sites [77,78]. Conversely, in fewer cases, empirical observations reveal that prospective assessments of large impacts on charismatic species can incentivize land developers to significantly reduce the footprint of projects [72].

Multiple studies of offsetting observe that measurements for biodiversity assessment are not as precise as claimed and in fact involve important judgments and negotiations to measure ecological value, both lost at the original site and gained at the offset sites [61,79–81]. As a consequence, this is an important space for negotiations and influence. The permittee often prefer metrics that reduce overall offsetting costs [76,82] by either underestimating harmful impacts [83] or exaggerating ecological gains [84]. While the current ecological research promotes ideas of evidence-based offsetting and proposes various forms of metrics and databases, it often ignores the localized policy implementation challenge of measurement.

Negotiations are framed with the extent of policy flexibility granted through the legislative process and frequently involve ecological knowledge, local assessments, and scientific literature on impacts as a means to defend interests and positions. Studies shed light on the tradeoffs between flexibility and strict implementation, with

industry actors obviously favoring more flexibility in compliance [85]. For example, flexibility could mean allowing the permittee to offset further away from the original site[86]. Flexibility may also apply to timelines for when offsets may be considered of the ecological value to equal the original site [74,87] or may apply to the contiguity or patchwork of the offsets [88].

Lastly, one high production cost for offsets lies in the price of accessing and securing land. For this reason, land developers may be tempted to negotiate either the total land acreage to be converted into offsets (a current situation in France) or the location of the land, favoring financial criteria rather than ecological ones [89,90]. Land availability also plays out in how offset programs unfold [91]. To cope with these financial costs, complementary incomes stemming from carbon mechanisms are increasingly regarded as a means to enhance biodiversity programs [92], though there are concerns about offsets' double counting. These elements point out the idea that flexibility takes the shape of informal negotiations around implementation criteria as well as circumvention of rules, especially when powerful economic industry actors put employment and development arguments forth.

With the push for more market-based approaches, new private-sector actors emerge with an interest and capacity to influence rules. In the USA, this mainly refers to conservation bankers, an industry with an annual market value of around US$350 million as of 2021 [93]. Complex and *ad hoc* rule-making is seen as harmful to the construction of the marketplace, while more standardized and consistent rules are seen to grow the market [94,95] and allow for a more level-playing field for conservation providers to manage risks [96,97]. These situations are likely to drive broader advocacy actions by conservation associations at national or federal levels to stimulate evolutions in policy design, and hereafter illustrate the dynamic processes of policy making.

As is the case with policy formulation, both industry and environmental groups use litigation to contest specific implementation rules and practices [72,76], a channel for policy influence that remains understudied. Similarly, environmental NGOs also use litigation to contest, delay, and even halt development projects. An accumulation of litigations around a similar topic or in a specific geography can also drive policy

changes from the ground up, as was evident in the emergence of market-based policies in California in the 1990s [98].

Studies of policy implementation can help theorize how influence is exercised through what might otherwise be considered mundane administrative tasks. It is in implementation that ecological sciences, political economies, and local institutions interact to shape how actors influence offsetting. Across cases, the range of actors and negotiations differ, but as this body of work expands, it will allow for much-needed cross-jurisdictional analysis. Such comparative studies can provide insights into how abstract rules around offsetting are translated into concrete governing arrangements, how actors across contexts similarly influence offsetting schemes as well as the localized improvisations that determine policy outcomes. Progressive policy changes may not lie in redoing offset laws and metrics but in strengthening organizational capacities, enabling adaptive governance, improving professional training, increasing implementation resources, and empowering administrative autonomy. An expanded body of case research will help rebalance against the dominant social scientific focus on policy design.

Ways forward

Offset governance comprises a host of actors with varying interests and resources, vying to mold agendas, laws, and practices to their advantage. While scientific models and experts are important at all policy stages, this review shows that focusing solely on the technical aspects of offsetting overlooks how competing interests in offset policies are asserted, negotiated, and institutionally stabilized. In synthesizing current research on how offset policies are subject to influence, we have illuminated the many blind spots that could inform offset governance if addressed. On this basis we state future directions for social science research and policy making.

First, more comparative case studies of biodiversity offset policies are needed to expand understanding of the different ways actors wield influence across economic, legal, and ecological contexts. Our review shows that scholarly understanding of influence channels and strategies is patchy: empirical studies are available for some countries – such as the USA, Australia, and France, but others - such as Germany, the Netherlands, Brazil, Colombia, and Mexico - barely appear in the literature. We also

found that the different policy stages have received uneven attention, with extensive work on discourses and laws, but less work about on-the-ground implementation, which is particularly sensitive to local ecological and institutional conditions. One explanation for this incomplete understanding is that most studies use qualitative methodologies to study policy-making and organizational influence. Because such work is time-consuming, expertise tends to be centered around national cases. Future research should integrate in-depth studies of biodiversity offset policies in a variety of institutional contexts and develop a comparative agenda to achieve a more systematic understanding of policy influence. This is an important way social science can contribute to the advancement of sustainable offset policies.

Second, analysis of the use of litigation in shaping biodiversity offset governance can inform ways to make the policy process more transparent and less vulnerable to existing structural inequities. Although the importance of litigation in environmental law is well recognized[99], there is a lack of analysis on how litigation is used in biodiversity offset governance. Litigation is a powerful strategy to contest, delay, and overall shape offset policies. It can be used across different stages, as well as to influence objects that may not directly relate to offsetting but indirectly determine offset outcomes. The use of litigation cuts both ways, it is used to weaken environmental laws as well as ensure effective enforcement. Capacities to exercise litigation are also conditioned by resources and political access, implying that well-endowed actors may be better positioned to wield litigation to their advantage, highlighting the ways narrow private interests can dominate the agenda, policy design, and implementation of biodiversity offsetting.

Third, effective offset governance requires strengthening feedback loops to create opportunities for learning across the policy processes. It is well recognized that the policy process is not as linear as described. Applied to biodiversity offsetting, the scholarship has tended to focus on specific stages and failed to fully allow for the feedback from implementation to policy formulation to agenda setting. As a result, agendas are set and policy designs advanced without consideration of implementation challenges. The global offsets agenda, for example, has relied on theoretical principles such as NNL and ecological models, and this has somewhat insulated agenda-setting from practical implementation challenges. Further research should investigate how actors look to constrict or loosen the channels of feedback itself.

Policymakers should embrace ideas of offsetting with caution. While attractive in theory, translating the theoretical idea of offsetting into actual policy arrangements is more complicated, and potentially risky for biodiversity outcomes. Yet, accounting for the co-produced nature of offsetting policies is not an argument to purge the science-policy interface of politics. Rather, the objective is to find ways to open the policy process to different stakeholders and interest groups while also shielding the process from harmful private influence. One strategy might be to consider the ratio of public, private, and community stakeholders involved in the policy debate. Some policy structures can require more private engagement while others may rely more on environmental non-profits or local agencies. For example, developing successful biodiversity credit markets would require opening the policy process to a variety of private interests which can risk undermining first principles such as avoidance and minimization. This may, in return, limit the state's ability to regulate private transactions and instead be pushed to accommodate private interests to prevent programmatic failures.

Science is an important input of offset policies but it is itself subject to political and corporate interests in ways that can undermine conservation goals. Given the entanglement of science and influence, it merits asking how institutions of environmental science and expertise can better serve the common interest, rather than individual or corporate agendas. This question may be broader than the offset debate, but it bears relevance here. What are the best practices in organizing the science-policy interface for biodiversity offsetting? The empirical evidence we reviewed urges us to be wary about the strategic influence of private entities conducting ecological assessments or science-based lobbying, but it also reminds us that science conducted in public institutions is not value neutral. It is thus important to open up the science-policy interface, making it more transparent and accessible to all stakeholders, especially during the implementation stage. Building up more participative biodiversity offset policies is a task for both regulators and social scientists who can steer and support such policymaking reform.

This review is relevant to other forms of market-based environmental governance, because processes of policy influence are not specific to biodiversity offset policies: asking who exert influences, on what policy aspect and through what channels of

influence can support new research agendas for sustainability policies more generally. Tackling any ensuing gaps would also enhance policy debates and implementation outcomes and would help to fulfill social scientists' responsibility to explain and problematize the practical concretizations of abstract ideas in environmental policymaking.

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Contributions

S.B. and R.G. conceived the study and wrote the original draft. S.B., R.B. and E.C.E. contributed to the writing, review and editing. S.B., R.G. and E.C.E conceived the figure. E.C.E. developed it with the help of ICTA-UAB communication office.

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Competing interests

The authors declare no competing interests.