Leakage and boosting effects in environmental governance: a framework for analysis

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Environmental Research Letters

LETTER

Leakage and boosting effects in environmental governance: a framework for analysis

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Abstract

In an increasingly interconnected world, leakage—broadly understood as unintended displacement of impacts caused by an environmental policy intervention—has become a major governance concern. Yet, leakage remains both loosely conceptualized and poorly understood as a phenomenon in policy making. To fill this gap and broaden the leakage research agenda, we conduct a state-of-the-art review of scientific assessments on leakage (particularly on land use) and combine it with conceptual and analytical frameworks from the environmental governance literature. We then propose a rigorous definition of leakage, discuss frequently overlooked political dimensions, and develop a typology of leakage pathways. Our analysis of leakage through a governance lens yields five core insights: (1) Leakage is not simply a mechanistic phenomenon, but a complex governance issue involving questions of institutional fit, interactions, and political agency. (2) Although the land use literature traditionally focuses on leakage through markets or activity displacement, a governance lens shows that it also occurs through information, motivation, or institutional channels. (3) As policy-makers may act strategically, the unintentionally of leakage should not be assumed but rather become an object of research. (4) A phenomenon not initially regarded as leakage can come to be framed as such through the action of 'problem brokers' and changes in policy fields. (5) Policy-makers and researchers should broaden their focus from only avoiding leakage to seeking positive spillovers and institutional synergies. These insights are illustrated with examples from two cases relating to land use policy in Brazil and Southeast Asia.

1. Introduction

Environmental issues are notoriously complex, spanning policy domains, economic sectors, jurisdictions and scales. As such, policies or other interventions seeking to address those issues often create second-order effects—or spillovers—that may go beyond their targeted scope (Kissinger *et al* 2011, Lenschow *et al* 2016, Liu *et al* 2018). For instance, energy governance may have implications for agriculture; changes in one country's land-use policy may affect neighboring countries; and sustainable supply chain initiatives may create effects that go well beyond their focus areas. Complexity is inherent in environmental governance in an ecologically and economically interdependent world, but that also represents a persistent policy challenge (Kissinger *et al* 2011, Liu *et al* 2018).

Leakage has been a particularly salient issue in that respect. Broadly understood as the unintended environmental impacts in one place that result from interventions elsewhere, leakage has been increasingly recognized as a major concern for policy effectiveness in environmental governance (Gan and Mccarl 2007, Meyfroidt and Lambin 2009). The concept was first introduced in the climate change mitigation literature to refer to 'the impact of the emission policies of the abating regions on the emission levels of non-abating regions' (Bruce *et al* 1995). It was further developed in the carbon sequestration context, especially in forestry, to describe an unanticipated reduction in net

carbon benefits as a consequence of the implementation of carbon sequestration projects (Brown *et al* 1997). The idea of leakage was then extended to other topics such as the displacement of land use change as a result of forest protection policies (e.g. Gan and Mccarl 2007, Oliveira *et al* 2007, Meyfroidt and Lambin 2009, Ostwald and Henders 2014). Leakage, however, remains a loose concept, sometimes used interchangeably with other notions such as that of 'spillovers' (see Pfaff and Robalino 2017). While widely described in empirical terms, the phenomenon is still poorly understood from a governance or policy process standpoint.

The aim of this letter is to approach and conceptualize leakage as a governance issue. Firstly, it characterizes what leakage is and the various ways through which it may happen. Secondly it pays attention to what can be called the *politics of leakage*, referring to the dimensions of human agency behind the causation, perception, and governance of the phenomenon. We draw primarily from literature on land use, where the leakage concept has perhaps been most elaborated, before connecting to the broader governance literature to develop insights for environmental policy at large.

This letter is structured as follows. Section 2 conceptualizes leakage and characterizes it as a governance issue. Based on the land use literature, that section develops a typology of leakage pathways and unpacks its often-overlooked political dimensions. Section 3 briefly discusses two cases—forest policy in Southeast Asia and the Amazon-Cerrado nexus in Brazil—to illustrate how policy and governance considerations can usefully broaden the leakage research agenda. Section 4 concludes the letter with core insights for understanding and tackling leakage in environmental governance.

2. Leakage through a policy and governance lens

2.1. Defining leakage

Leakage can be understood as a subset of the broader term spillovers. Spillover can be any form of collateral effect that takes place across ('over') established governance boundaries, be they geographical, temporal, jurisdictional, sectoral, or political (Liu *et al* 2018, Meyfroidt *et al* 2018). Spillovers relate closely to the notion of 'telecoupled' systems—as geographically distant systems that still influence one another (Liu *et al* 2015)—as well as to the concept of the Anthropocene and the realization that global ecological and economic systems are deeply interconnected (Biermann *et al* 2012, Dryzek 2016).

In contrast to the broad meaning of spillovers, however, leakage is usually understood in a narrower sense. It refers to a specific type of spillover in which an environmental policy indirectly triggers impacts that go against its aims, thus reducing the overall benefit of the intervention (Meyfroidt *et al* 2018). This definition allows for the identification of three key elements that characterize leakage in the strictest sense:

(1) Impacts occur as a causal effect from an environmental policy intervention.

(2) The variable affected is the one targeted by the intervention (e.g. deforestation induced by an anti-deforestation policy qualifies as leakage, as well as carbon emissions induced by climate change mitigation policies).

(3) The spillover has a negative effect on the targeted variable.

The third criterion is occasionally relaxed, leading some to discuss 'positive' versus 'negative' leakage. We however think that this can become confusing and that the word leakage has an inherently negative connotation. Therefore, we will use the term *boosting effect* for positive spillovers that fulfill the two first criteria but not the third (i.e. when the spillover has a positive effect on the targeted variable).

2.2. Leakage as a governance challenge: institutional fit and interactions

Questions of why leakage happens, how to prevent it and how to address it are critical to environmental governance. Leakage is usually regarded as a result of deficient policy design, which in turn leads to limited effectiveness and possibly outright failure. However, the effectiveness and broader performance of policies cannot be adequately understood out of context. Such considerations are highly dependent on the nature of the environmental issue at stake as well as on the existing social, political and institutional setting.

The concepts of *institutional fit* and *interactions* (or interplay) may prove helpful in understanding leakage through a governance lens. Institutional fit refers to how well the design of a policy or another institution suits an environmental issue and its context (Young *et al* 2008, Vatn and Vedeld 2012). It is usually divided into an ecological and a social dimension. Ecological fit relates to how an intervention matches the biophysical characteristics and dynamics of the environmental issue at stake, such as spatial scale, feedback loops, etc (Epstein *et al* 2015). Usual examples of ecological misfit include conservation initiatives that target individual key species while ignoring interspecies relations, as well as jurisdictional approaches that cover only part of a landscape in the face of broader land use change processes. Leakage is a common outcome of such misfits, as in the case of national or subnational policies aimed at tackling global climate change.

Social fit, in turn, relates to how well an intervention suits the prevailing values, norms, interests and

preferences of an environment, and how it targets the appropriate decision-making actors. Conservation initiatives are known to be more effective when they reflect those actor features in the existing social setting (Meek 2013). As social orders change, institutions may therefore experience situations where 'fit turns into misfit and back' (Haller *et al* 2013). Conservation interventions that 'backfire' or turn into perverse incentives due to mismatches with prevailing norms and behaviors are clear examples of how social misfit can lead to leakage (Alpízar *et al* 2017a; see also 2.3).

Leakage also relates to the subject of institutional interactions. In an increasingly interdependent world, institutions aiming to prevent or address environmental issues frequently interact with one another and produce impacts elsewhere (Kissinger *et al* 2011, Visseren-Hamakers 2015, Bastos Lima *et al* 2017). Interactions may exist even within a single institutional framework, as in the case of the Sustainable Development Goals (Ehrensperger *et al* 2019). Such interactions may be conflictive when they compromise each other's effectiveness, innocuous when there are no perceived effects, or synergistic when there is an added value from the interaction of those policies (Bastos Lima *et al* 2017). In the case of land use policy, therefore, dealing with leakage and boosting effects requires managing interactions amongst different land use systems and various institutions in place (including policy drivers of land use change and pre-existing conservation policies).

A governance lens thus suggests that leakage and other forms of spillover are not simply side-effects to be avoided at all costs through some perfectly designed policy-making. Rather, environmental governance is largely a matter of managing complexity, including spillovers and institutional interactions (Visseren-Hamakers 2015, Bastos Lima *et al* 2017, Lambin and Thorlakson 2018). Researchers and policy-makers interested in leakage and boosting effects may therefore need to also consider a broader range of issues, instead of only looking at individual policy design. These may include issues of institutional coordination and policy coherence, as well as those concerning how to minimize mismatches and maximize synergies in a dynamic way (Sterner *et al* 2019).

2.3. Leakage pathways

When approaching the issue of leakage from a governance standpoint, understanding how it can happen is key. Causal relationships between sustainability interventions and spillover effects have long been studied through modeling and statistical techniques (see Golub *et al* 2013, Jadin *et al* 2016), and recent syntheses have described some of their main pathways or mechanisms (see Pfaff and Robalino 2017, Meyfroidt *et al* 2018). However, while most studies focus on economic or material means, a broader governance scope reveals that leakage and boosting effects can also occur through other pathways, such as diffusion of information or motivations. Based on a state-of-the-art review of the land use literature, this section takes a comprehensive outlook on leakage to summarize the various mechanisms identified. It then presents these mechanisms as a typology of pathways (see table 1).

2.3.1. Activity displacement

Most described cases of leakage operate through economic mechanisms, either by *direct leakage*—changing the behavior of the actors targeted by the policy intervention—or by *indirect leakage*—changing the incentives facing actors not targeted by the intervention[1]. The former is commonly referred to as *activity leakage* (Meyfroidt *et al* 2018) and occurs when agents shift the activities targeted by an environmental intervention from one place to another. Activity leakage may occur at different scales. At the farm level, payments to set aside land may for example lead to reallocation of agricultural inputs to land not covered by the set-aside policy (Alix-Garcia *et al* 2012, Uchida 2014). In agricultural supply chains, large multinational companies may reallocate capital or physical assets from one jurisdiction to another in response to changes in land-use policies (le Polain De Waroux *et al* 2016). Restrictions on land-use activities (e.g. through the establishment of protected areas) may also induce migration, resulting in the shift of environmental pressures (although these effects are ambiguous and context-dependent, sometimes leading to reduced pressure elsewhere (Pfaff and Robalino 2017)).

Activity leakage is an example of what the literature on trade and environment refers to as 'industrial flight', or the push effect of environmental policy interventions. It is a typical example of institutional misfit, where leakage occurs because of insufficient (spatial) coverage of the policy intervention. The likelihood of activity leakage is higher where: production factors or inputs are highly mobile (such that labor and capital affected by land-use policies are easily reallocated to places with available and accessible land), there is a lack of off-farm alternatives or cultural preferences for land-based activities, or the Sunk costs of capital or labor investments in the initial place are not too large (Wunder 2008).

2.3.2. Market-mediated effects

Indirect leakage through economic channels is often termed *market-mediated leakage* (Pfaff and Robalino 2017). Market-mediated leakage can result from changes in either input prices or output prices, sometimes referred to as 'land-market leakage' or 'commodity-market leakage' (Meyfroidt *et al* 2018). An example of the former is when land prices go up, for instance due to biofuel policies increasing land

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[1] Direct and indirect leakage correspond, alternatively, to what Aukland *et al* (2003) call primary and secondary leakage.

Table 1. Summary of the typology of pathways through which leakage or boosting effects take place.

Type	Pathway/mechanism	Agency[a]	References
	Reallocation of inputs: Inputs (e.g. labor, capital, or agricultural inputs) freed by some conservation intervention may be reallocated on the farm, leading to increased environmental pressure on other land	Direct	Alix-Garcia *et al* (2012), Uchida (2014)
Activity	*Migration*: Restrictions on agriculture or other extractive activities could lead to out-migration from regions facing conservation interventions, potentially raising environmental pressures elsewhere (but reducing them locally)	Direct	Wittemyer *et al* (2008), Herrera Garcia (2015)
	Corporate reallocation of resources: In response to conservation policies in one jurisdiction, agricultural corporations may reallocate resources (e.g. investments, marketing) to other regions	Direct	le Polain De Waroux *et al* (2016)
Market-mediated	*Changes in input prices*: land-use restrictions tend to raise the price of land and to lower the price of other inputs (e.g. labor, fertilizers), creating incentives for raising production elsewhere	Indirect	Richards (2015), Pfaff and Robalino (2017), Hertel (2018)
	Changes in output prices: land-use restrictions tend to reduce agricultural or forestry output, raising prices and creating incentives for raising production elsewhere	Indirect	Murray *et al* (2004), Alix-Garcia *et al* (2012), Golub *et al* (2013).
Information	*Learning*: by reducing uncertainties about the costs and benefits of conservation, uptake may increase on land not targeted or spread to other jurisdictions, typically resulting in boosting effects	Direct/ indirect	Lewis *et al* (2011), Robalino and Pfaff (2012)
	Enforcement: increased monitoring of those targeted by a policy intervention may affect the behavior also of non-targeted agents	Indirect	De Andrade and Chagas (2018)
Motivation	*Motivation crowding*: conservation interventions may crowd out intrinsic motivations to conserve, leading to less conservation among agents not covered by the intervention or by those targeted after the intervention ends (temporal leakage)	Direct/ indirect	Kits *et al* (2014), Alpízar *et al* (2017a, 2017b)
Institutions	*Institutional interactions*: conservation interventions by one actor (public, private) in one location may result in policy or norm changes among other actors or in other regions. These induced policy or norm changes may be either supporting or countervailing	Indirect	Bastos Lima and Gupta (2014), Lambin and Thorlakson (2018)

[a] Direct leakage refers to mechanisms where leakage is caused by the agents targeted by the policy intervention, whereas indirect leakage is caused by other agents.

demand or conservation policies restricting land supply, thereby capitalizing farmers and facilitating expansion in forest frontier areas (Richards 2015, Egeskog *et al* 2016, Richards and Arima 2018). An example of the latter is the indirect land-use change effects of biofuel policies; increased demand for agricultural land for biofuel production in one region leads to changes in global crop prices, resulting in agricultural expansion (and associated carbon emissions) in other parts of the world, mediated through global agricultural markets (Hertel *et al* 2010).

Risks of market-mediated leakage depend not only on the magnitude of the price changes (in input prices, such as labor or fertilizers, or output prices for agricultural or forestry commodities), but also on the extent to which prices transfer across space and those changes are absorbed through reduction in demand and/or intensification in production (Hertel 2018).

2.3.3. Information

Informational spillovers are typically positive (i.e. boosting effects), occurring through learning processes that result in reduced uncertainty around the costs or benefits of conservation practices. For instance, agents targeted by a conservation intervention may apply the policy-compliant practice on non-treated land, continue the practice even after the intervention has ended, or spread it among untreated agents (Pfaff and Robalino 2017). Examples of the latter are: the study by Lewis *et al* (2011) showing how the adoption of organic dairy farming practices spread between farms due to reduced uncertainties and costs of information acquisition; and the study by Robalino and Pfaff (2012) that, by showing that forest clearing by Costa Rican farmers are affected by their neighbors' deforestation decisions, implied that policies promoting forest clearing or conservation will spill over to surrounding areas.

However, learning may also take place at the institutional level, leading to the diffusion of policies across jurisdictions (Stone 2001, Holzinger *et al* 2008). For instance, De Andrade and Chagas (2018) show that transfer of information from Brazilian municipalities blacklisted by the government for their high deforestation rates to neighboring municipalities had the effect of lowering deforestation also in the latter. Another well-described example of institutional learning is the 'latecomer effect', where institutional actors who confront a given problem following other actors can learn from these other actors to exhibit higher clarity of purpose, wield concentrated power, and accomplish their ends faster (Rudel *et al* 2019). Note, however, that information spillovers can also be negative, operating through social networks and herd behaviors that may reinforce loopholes in existing governance frameworks (le Polain de Waroux 2019).

2.3.4. Motivations

Motivational leakage occurs when an intervention affects the intrinsic motivations of an agent. For instance, monetary compensation for a conservation practice—e.g. through Payment for Ecosystem Services (PES) programs—can 'crowd out' intrinsic motivations and lead to less conservation after the intervention ends (a form of temporal leakage). Kaimowitz (2008) discusses how farmers in Mexico and Nicaragua under PES contracts threatened to clear forests if payments cease. This is an example of temporal mismatch between the policy intervention and the problem it seeks to solve. It may also occur among non-covered agents, particularly if the policy is perceived as unfair (Nordén *et al* 2013, Kits *et al* 2014, Pfaff and Robalino 2017, Alpízar *et al* 2017a, 2017b).

In other cases, however, motivational spillovers have been found to be positive, as exemplified by a study of conservation payments in Mexico that 'crowded in' intrinsic motivations to conserve land (Alix-Garcia *et al* 2018). In general, the crowding in of intrinsic motivations happens when actors feel that interventions are supportive, whereas crowding out occurs when interventions are perceived as controlling (Frey and Jegen 2001). In line with this, Ezzine-de-Blas *et al* (2019) argue that PES programs are more likely to reinforce intrinsic motivations when they foster (i) competence (by recognizing skills and supporting personal development), (ii) autonomy (by an inclusive design), (iii) social relatedness (by building on reciprocity, distributive and procedural equity, and inclusiveness), and (iv) environmental relatedness (feeling of belonging, well-being and awareness of environmental quality). In other words, the social fit of a PES program will determine whether intrinsic motivations are crowded out (leakage) or in (boosting).

2.3.5. Institutions

Finally, leakage and boosting effects may also take place via institutional channels. There is extensive literature on policy interactions and institutional interplay that catalog various ways in which policies may change, support or undermine one another: see, e.g. Lambin *et al* (2014) and Lambin and Thorlakson (2018) for reviews related to land use in the Tropics, Visseren-Hamakers (2015) and Bastos Lima *et al* (2017) for discussions on institutional synergies and interactions, and Holzinger *et al* (2008) on policy harmonization, learning and regulatory competition. While this literature shows that policy interactions—within or across jurisdictions—are important for environmental outcomes, these mechanisms have rarely been linked to discussions on leakage and spillovers.

Examples of leakage or boosting effects through institutional pathways involve conservation interventions that affect norms or policies not aimed at, but which will indirectly impact the target variable (deforestation, carbon emissions, etc) elsewhere. For instance, the creation of protected areas may affect public infrastructure investment plans, with potential conservation implications for non-targeted areas (Pfaff and Robalino 2017). Similarly, voluntary certification standards have occasionally led to changes in government regulations. There are cases of boosting effects through the transfer of norms across institutional settings (private to public) (Lambin and Thorlakson 2018), as well as where private certification standards have prompted governments to establish rival, but weaker, sustainability standards that might undermine overall benefits. The Indonesian and Malaysian governmental initiatives to establish parallel, public palm oil certification systems to supplant the Roundtable on Sustainable Palm Oil (RSPO) certification may be regarded as examples of that (Bastos Lima and Gupta 2014, Pramudya *et al* 2018).

2.4. The politics of leakage

In order to fully appraise leakage and other spillovers, it is crucial avoid interpretations that regard them as mechanistic in nature, as if they merely were domino effects. There is a whole dimension of agency, often overlooked in leakage assessments, that a governance lens can help uncover. Actors play roles not only as economic agents (e.g. driving land use change), but also as political agents in governance (Biermann and Pattberg 2008). Actors constantly seek to create, eliminate, or modify institutions to suit their views (Dimaggio 1988, Weik 2011), and they often group in advocacy coalitions to pursue the concretization of policy goals (Sabatier 1988, Weible *et al* 2011). Therefore, leakage and other spillovers are not only by-products of policy design or institutional (mis)fits, but also matters of environmental politics.

Agency is relevant to policy debates on leakage and other spillovers in at least two ways. First, assessments have tended to carry the underlying assumption, implicitly or explicitly, that leakage is always

unintentional. Although it is reasonable to assume that certain governance actors may purposefully displace environmental impacts elsewhere, this has been frequently overlooked in research. Second, as defined, leakage and boosting effects concern a target variable used as the reference for assessing policy effectiveness. However, environmental issues or impacts are not always fixed or consensually defined. Rather, they are often subject to different interpretations and competing framings (Baumgartner and Jones 1991, Kingdon 1995, Knaggard 2015), implying that what constitutes leakage can be a question of debate and contestation.

2.4.1. Unintended by whom?
Research on leakage and other spillovers generally assumes these effects to be unintentional (see Van der Werff and Di Maria 2011, Davies and Oreszczyn 2012, Lambin *et al* 2014, Lenschow *et al* 2016). As such, it assumes an invariable unawareness from the part of policy-makers about the full range of impacts from their interventions. It is as if those behind environmental interventions were always either uninterested or unable to appraise what may happen beyond their targeted focus-area. This assumption, however, does not hold in light of what is known about agency in governance and strategic policy-making.

Various theories and frameworks attempt to explain how agents operate in governance. Some assume actors to be self-interested, profit-maximizing agents; others are more nuanced in recognizing that different principles, norms, and belief systems may guide human action (Sabatier 1988, Weik 2011, Schlager and Weible 2013). Nevertheless, there is a consensus that agents tend to engage strategically with regard to environmental issues. Environmental or land-use governance, not unlike other fields, is one of 'highly contested and competing goals, distinctive and divisive values' (Willke and Willke 2008). Policies and their spillover effects, therefore, arise out of compromises between diverging interests and views.

We argue, therefore, that the unintentional character of leakage should never be assumed; rather, it is to be an area of research. Certain governance agents may be well aware of the second-order impacts that a given environmental intervention could create. Such effects may actually suit a strategy and even be part of the very reason why certain agents have advocated for a given intervention in the first place. In other words, leakage and other spillovers may be part of an agent's policy strategy. Therefore, it is important to distinguish between strategy and unawareness, for this understanding will inform how to eventually tackle leakage effects. This attribution must always be actor- or coalition-specific, as some policy-makers may be playing chess while everyone else is playing checkers. Information imbalances or a better understanding of the dynamics across governance boundaries may allow some agents to grasp a wider range of impacts from a

possible intervention and account for that in their planning.

2.4.2. Problem brokering and issue framing
Governance issues usually are strategically framed in policy discussions, and agendas can change (Slothuus and de Vreese 2010). For one, what qualifies as a 'negative' spillover impact—a criterion to characterize leakage—is largely subjective. A condition or a situation may not be perceived as a problem unless it is framed as one. The legal clearing of native vegetation in tropical countries, for example, is a contentious subject of dispute between actors who approve of it, framing this as 'development', and others who see it as a problem that demands action and policy changes. Getting people to see a condition as a problem is a 'major political accomplishment' (Kingdon 1995). This is the role played by *problem brokers*, agents who purposefully and strategically portray certain situations as public problems for policy-makers to act upon (Knaggard 2015).

Environmental issues are frequently the object of multiple concurrent definitions and framings. *Issue framing* refers precisely to characterizing situations in a particular way, often so that it matches or serves one's political agenda (Slothuus and de Vreese 2010). This is clearly seen, for instance, in the constant disputes over what should be characterized as deforestation. Environmental issues may also overlap, aggregate into larger issues, or be broken down into smaller, more specific ones (e.g. climate change adaptation being part of the larger issue of climate change). These issues can, in turn, constitute several policy fields or domains, broadly understood as 'more or less established areas of policy that give meaning to common problems' (May *et al* 2006). Rather than being static, policy fields are thus institutionally constructed and develop over time, depending on how issues are framed and how agents converge around them (Lyngaard 2007, Massey and Huitema 2013).

The dynamic nature of policy fields means that what actually constitutes the variable being taken into consideration in leakage assessments can be the object of debate and may change over time. A case in point is the debate over what is defined as a forest, and whether an industrial plantation (e.g. of oil palm or eucalyptus) can be classified as forest (see Chadzon *et al* 2016). An illustrative example of the implications of this debate—which we explore in further detail in section 3—regards negative spillovers from Amazon protection policies on the Cerrado savannas. Whether this is regarded as leakage depends on how the variable is defined, whether 'native vegetation', 'rainforest', or some specific environmental concern such as loss of 'carbon stocks' or of 'biodiversity'. The fact that policy perceptions have changed over time alongside growing global recognition the Cerrado is a clear achievement of issue framing and of problem brokers in bringing it into the scope of consideration.

Leakage, boosting effects and other spillovers therefore may be clear analytical categories, but their application in practice does not escape the grips of environmental politics. It is important to realize that even if these concepts are clearly defined, their interpretation may still change along with the understanding of the environmental issue at stake. It may always be the case that different framings or narratives by different groups compete as alternative representations of a situation.

2.5. A framework for analysis

A governance lens on leakage opens up questions of intentionality, issue framing, and agency, i.e. who decides the scope of a policy intervention and what the outcome variable(s) of interest is, and on what grounds? Leakage can be said to occur as a result of policy gaps (mismatches between the policy scope and the outcome variables it seeks to address), causing the displacement of pressures. However, that displacement will only be framed as leakage if it falls within what is understood to be its area of concern (the policy field), which is a matter of political debate. By reframing the relevant outcome variables of a policy, displacement can be framed either as leakage or not. If displaced pressures are regarded as positive, that may be considered a boosting effect when occurring within the same policy field, or more generally as a positive spillover if happening outside of it in the broader policy landscape.

Figure 1 illustrates such discussions on issue framing, policy fields and agency as a framework to understand and analyze leakage through a governance lens. It should be noted that 'policy scope' does not necessarily refer to a single policy, but rather to the scope of the policy framework in place, be it a single intervention or a policy mix. Over time, this scope—as well as the policy field—can be expanded to address perceived limitations or narrowed to focus and externalize certain consequences.

3. A broader leakage research agenda: two illustrative cases

3.1. Forest policy in Southeast Asia

Although leakage has typically been treated as a policy design failure, a governance lens allows for a more detailed understanding of its workings in the policy process. One relevant illustrative case is that of tropical forest conservation in Southeast Asia, which has received major international attention, including through policies such as REDD+[2]. The fragmentary adoption of REDD+ actions in Southeast Asian countries, however, can be considered an institutional

misfit, as there is a spatial mismatch between the policies' national coverage and the increasing regional integration of those economies (Ingalls *et al* 2018). This has left room for the displacement of deforestation from early-adopters and countries with more rigorous carbon-related regulatory regimes to late-adopters of REDD+. In this regard, our analytical framework can shed light and provide insights on a number of often-overlooked factors concerning leakage from REDD+ actions and other forest conservation policies in Southeast Asia.

For one, identifying levers to address such misfits requires acknowledging that, far from being an unintended and unexpected consequence of poor policy design, the implementation of forest policies and resulting deforestation displacement across Southeast Asian countries is partly an intentional result of governments' strategies. Countries displacing their environmental impacts (e.g. Vietnam) rely on this as a way to achieve their domestic goals for environmental conservation, regional integration, and economic development, through the processing, exporting and consumption of commodities produced in land deforested in their neighbors. Countries that host deforestation, mainly through large-scale land acquisitions, in turn see these activities as core to their national economic development by providing an inflow of foreign capital, job creation and income prospects from natural resource extraction (Ingalls *et al* 2018). Such displacement is thus embedded in governance and political strategies, rather than being an unintentional outcome of myopic conservation policies.

In the case of Vietnam, the Vietnamese government began severely restricted wood extraction from natural forests in the 1990s. At the same time, it strongly supported the growth of a booming wood-processing industry, first oriented towards the domestic demand for construction and then increasingly towards exports (Meyfroidt and Lambin 2009). The expansion of tree plantations was also promoted, but even over-optimistic government estimates acknowledged that those policy goals were impossible to achieve without increasing raw wood imports from neighboring countries. Such wood imports, often illegal, require interactions between high-level officials and military officers from Vietnam and from source countries, as well as among large forestry and furniture enterprises that are tightly controlled by the government (EIA-Telapak 2008, Meyfroidt and Lambin 2009, EIA 2018). All of these developments suggest a high level of policy planning, rather than unawareness.

This strategy is, in fact, supported by Vietnamese policies such as the wood import quotas issued by Vietnamese provinces neighboring Cambodia, which are incoherent with Cambodia's log export ban (EIA 2018). Until 2016, all timber imported legally into Vietnam was considered to be legal regardless of the situation in the country of origin (Ingalls *et al* 2018). Although unequivocal evidence of intentionality would require

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[2] REDD+ refers to Reducing Emissions from Deforestation and Forest Degradation in developing countries, a results-based finance mechanism of the United Nations Framework Convention on Climate Change (UNFCCC).
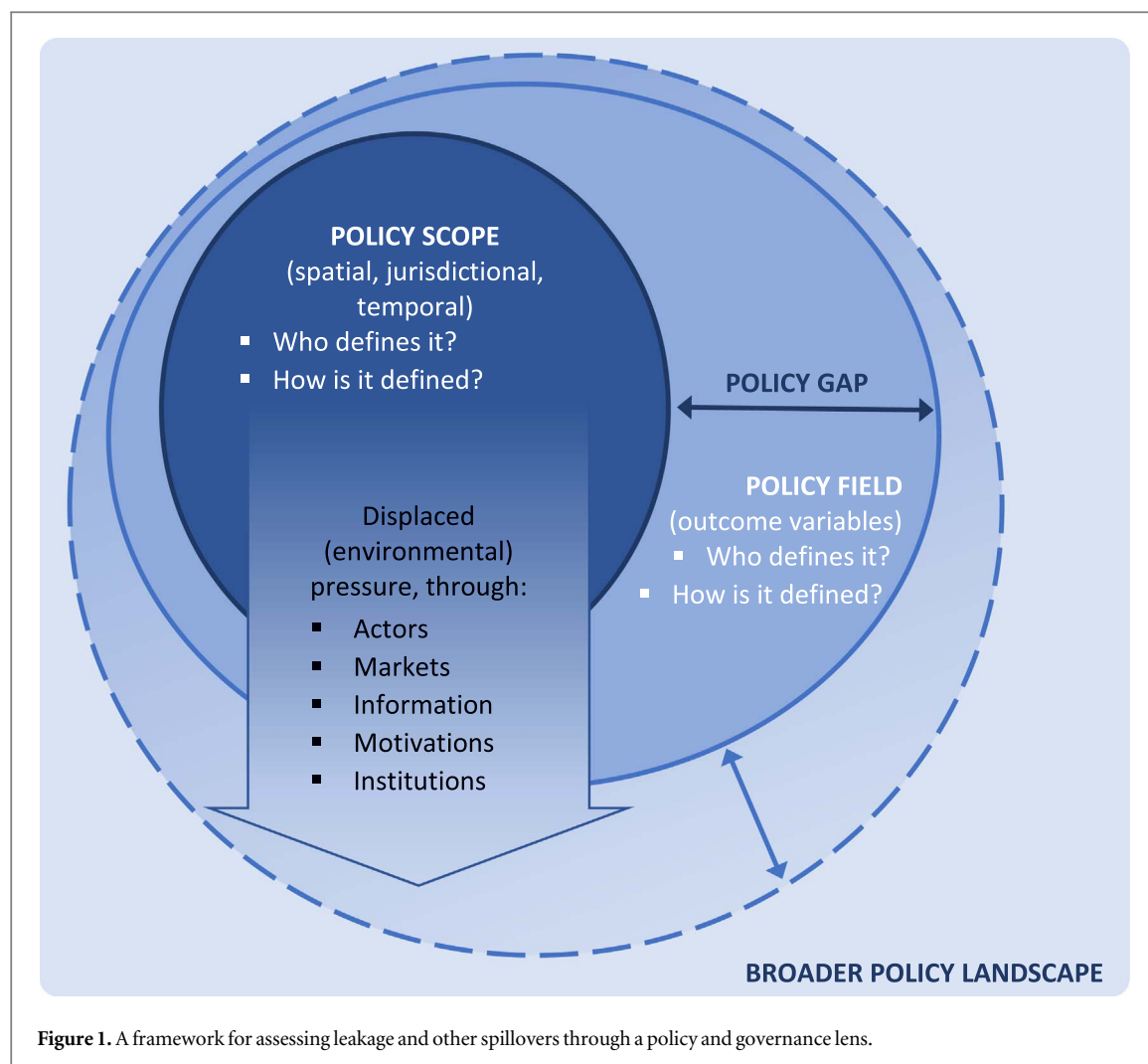
Figure 1. A framework for assessing leakage and other spillovers through a policy and governance lens.

access to first-hand documents or testimonies from policy-makers, which are not available for Vietnam, this shows that policy-makers were aware that their policy goals could only be reached with leakage. The pattern appears similar in other industries such as rubber, where state-owned Vietnamese enterprises, supported by other branches of the government such as embassies, play a crucial role in facilitating leakage (Ingalls *et al* 2018).

The issue of transboundary displacement of deforestation is also subject to competing framings, such as discourses of national development on the one hand and of global environmental degradation on the other. The possibility to frame the situation as 'leakage' depends on which one of these two discourses is prominent. For example, the combination of very rapid economic growth with stringent policies on the protection of domestic forests has allowed Vietnam to simultaneously frame itself both as a leader in regional conservation policies and as a strategic partner for investments (Ingalls *et al* 2018). This supported the efforts of Vietnamese companies and authorities to play a growing role in forest and land-based activities in neighboring countries, and to frame these as supporting their neighbors' national development rather than as leakage of natural resource extraction.

Finally, as to the mechanisms through which such spillovers operate, they may be particularly varied in well-integrated regions such as Southeast Asia. Their economic integration around land-use sectors such as agriculture and forestry suggests that activity as well as market-mediated leakage have taken place (Ingalls *et al* 2018). However, boosting effects through institutions—in the form of policy emulation—may also have contributed to positive spillovers from countries that have already achieved a shift from net deforestation to reforestation, countering some of the leakage effects (Rudel *et al* 2019). A research agenda on forest governance and leakage in Southeast Asia, therefore, needs to be comprehensive and take these various governance dimensions into account.

3.2. The Amazon-Cerrado nexus and deforestation in Brazil

Land use changes and deforestation for the expansion of agriculture in Brazil, too, have been a topical environmental issue and frequent object of leakage assessments (e.g. Alix-Garcia and Gibbs 2017, Dou *et al* 2018). Soy and cattle have become major drivers of conversion both in the Amazon and in the Cerrado, Brazil's highly biodiverse savanna. In response, various

public and private, jurisdictional and supply-chain initiatives have been put in place to promote more sustainable land use (Lambin *et al* 2018). As governmental support for environmental protection in Brazil deteriorates, the sustenance and success of such interventions have become even more critical (Pereira and Viola 2019). However, while leakage discussions have been crucial in appraising policy effectiveness, they might also need to be broadened for a more comprehensive understanding of that governance context.

The Amazon Soy Moratorium signed by agribusiness in partnership with environmental NGOs in Brazil is a case in point. The agreement, signed in 2006 by major agroindustries pledging not to source soy from areas deforested in the Amazon after a cutoff date, was lauded as a success for many years, as the conversion of rainforest into soy cropland indeed decreased (Gibbs *et al* 2015). However, as soy rapidly expands over the Cerrado, there is a growing perception that those land-use impacts have *leaked* from the former biome to the latter (Dou *et al* 2018).

Given such impact displacement, and irrespective of other drivers that may also be at play, governance efforts such as those towards zero-deforestation commitments (see Garrett *et al* 2019) may need to address some important questions. For one, what is the environmental issue (i.e. the variable) under analysis: loss of native vegetation or exclusively rainforest loss? Is the underlying concern biodiversity protection or carbon sequestration? Although this is not usually stated explicitly, the framing of the issue has clearly shifted over the years. Perceptions of the Cerrado's value as an ecosystem (for biodiversity conservation, freshwater availability, livelihoods, etc) have substantially increased in recent years, leading some actors to frame that diversion of soy expansion as a case of leakage. The Soy Moratorium, however, was essentially a response to *Amazonian* conversion (as illustrated by Greenpeace's 2006 report '*Eating up the Amazon*' that helped create momentum that to the creation of the moratorium). The belated critique that the moratorium is flawed for not also covering the Cerrado can, therefore, be considered the result of changing framings and the widening of this policy field to include more than just the Amazon (see Soterroni *et al* 2019).

The extent the which the eventual displacement of impacts from the Amazon to the Cerrado was intentional must also be questioned, for this will suggest very different courses of action to eventually mitigate those impacts. Susanna Hecht characterizes the Brazilian Cerrado and other South American woodlands as 'sacrifice zones' to where agricultural expansion is deliberately (or at least knowingly) displaced in order to save the Amazon biodiversity hotspot and other 'high forests' (Hecht 2005, Oliveira and Hecht 2016). If the 'sparing' of the Amazon has indeed been consciously agreed on at the expense of the Cerrado, then

actors with an interest in protecting the Cerrado may need to prepare to counter interests and veiled land use strategies. In other words, the political and governance efforts needed to fix 'flawed' policy design are very different depending on whether those side-effects are accidental or purposeful.

Finally, through which pathways does such leakage take place? This may require appraising not only activity or market-mediated displacements, but also the interactions between the sustainability interventions put in place (e.g. the Soy Moratorium) and existing policy or market drivers for soy or cattle expansion across those ecosystems. A comprehensive assessment for sustainable land use governance may require concerted efforts to both understand and, eventually, manage those interactions towards boosting effects and synergies.

This broad scope of questions illustrates how approaching leakage through a governance lens allows for a more thorough appraisal of such policy issues, their effectiveness, and the contexts where they are inserted. Those are important avenues for further research.

4. Conclusions

Leakage and other spillovers from environmental policies have become a major area of research. In order to provide greater conceptual rigor and a more comprehensive understanding of those issues from a governance standpoint, this letter has developed a working definition of leakage and an analytical framework that includes a typology of pathways and often-overlooked political dimensions. This exercise provides five core insights that may shed light on analyses of leakage and indicate important avenues for further research. Although they emerge from assessments on land use policy, these considerations may also apply and could be tested in other domains of environmental governance, such as energy use or food consumption.

First, leakage and other spillovers can only be adequately understood within their specific socio-economic and institutional contexts. Rather than merely mechanical processes akin to domino effects, those are complex and nuanced governance issues that involve issues of ecological and social fit, institutional interactions, and political agency.

Second, although the literature (particularly that on land use) has focused primarily on activity displacement and market-mediated mechanisms (e.g. prices, input reallocation, production displacement), we highlight that leakage and other spillovers can also occur through learning, changes in agent motivations, information dissemination, and policy interactions. While there is growing literature on such leakage mechanisms (especially on motivation crowding), we

urge the land-use science community to further explore and also analyze institutional and informational pathways.

Third, the unintended character of leakage and other spillovers, and the implications thereof, should not be assumed, but become an object of research. Policy-makers may well be aware of the collateral or second-order effects of the environmental interventions they put in place. Therefore, such issues cannot be automatically attributed to unawareness. Clearly a different approach is needed when the spillovers are deliberate and due to strategic policy-making. Simply informing well-intended but myopic policy-makers about the supposedly unintended effects of their decisions may not work. Rather, understanding the role of political agency in leakage can better equip researchers and policy-makers to analyze and, eventually, deal with the issue.

Fourth, the understanding of the variable targeted by an intervention can change over time. Not only do policy agendas change, but issues also are continuously framed and reframed in the policy process (e.g. what constitutes a forest, why it matters, what deforestation means). As such, something that initially may not have been regarded as leakage can suddenly come to be so. In this, a key role is played by 'problem brokers', agents that strategically frame given conditions as problems that need to be acted upon.

Fifth, in an ecologically, socially and economically integrated world, spillovers may be very hard to avoid, if at all (Sterner *et al* 2019). Awareness about their different pathways can help analyze, pre-empt and manage different forms of leakage. Much more attention may be needed on adaptive management that allows to redesign policies when unwanted spillovers are identified. However, from a policy-making standpoint, the aim of having flawless design can be relaxed and more attention be paid to interactions management and to how to purposefully create boosting effects and various synergies. If complexity is inherent in environmental issues, then environmental governance may need to work not only on, but also *through* spillovers.

Acknowledgments

Data statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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