SPECIAL FEATURE: ORIGINAL ARTICLE

Networks of Action Situations in Social-Ecological Systems Research

Challenges for environmental governance: policy issue interdependencies might not lead to collaboration

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Abstract

Policy actors address complex environmental problems by engaging in multiple and often interdependent policy issues. Policy issue interdependencies imply that efforts by actors to address separate policy issues can either reinforce ('win–win') or counteract ('trade-off') each other. Thus, if interdependent issues are managed in isolation instead of being coordinated, the most effective and well-balanced solution to the underlying problem might never be realised. This study asks if reinforcing and counteracting interdependencies have different impacts on perception and collaboration. Our empirical study of collaborative water governance in the Norrström basin, Sweden, shows that policy actors often avoid collaborating when the policy issues exhibit reinforcing interdependencies. Our evidence indicates a perceived infeasibility of acting on reinforcing interdependencies. We also find that actors do not consider counteracting interdependencies ('trade-offs') at all when they engage in collaboration. Further, even though actors were aware of counteracting and reinforcing interdependencies, our analyses suggest they might be less aware of the former. These findings illustrate that actors either avoid each other due to policy issue interdependencies or, at best, ignore existing interdependencies when engaging in collaboration. Our study highlights the importance of problem perception in accomplishing integrated solutions to complex environmental problems, and of how understandings of different types of interdependencies shape collaboration in environmental governance.

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Introduction

Policy actors often address complex environmental problems by dividing them into multiple *policy issues* (Angst 2019; Brandenberger et al. 2020; Hedlund et al. 2021a; Kirschke et al. 2017; Lubell 2013). This compartmentalisation is due to several factors. For example, any single policy actor does not often have the resources to resolve every single aspect of a problem. Actors may also have a perceived need to make complex problems tangible. Additionally, certain governance structures divide responsibilities and varying interests (Jacob and Volkery 2004; Laumann and Knoke 1987; March and Simon 1958). Yet, the boundary-spanning nature of environmental problems implies that policy issues are interdependent and benefit from coordinated action (DeFries and Nagendra 2017; Klijn and Koppenjan 2000; Liu et al. 2015; Provan and Kenis 2007). For example, the net effect of addressing one policy issue (e.g. the implementation of downstream wetlands regulation) might not significantly

improve a goal (e.g. water quality) unless another policy issue (e.g. regulation of upstream sources) is also addressed. Hence, policy issue interdependencies are an important problem attribute with significant implications for environmental governance.

While existing environmental policy research has thoroughly described policy issue interdependency in many different contexts and systems (Angst 2019; Hedlund et al. 2021b; Fried et al. 2022), studies rarely examine actors' perception of and acts upon interdependency. Studies either describe problems as indivisible (Head and Alford 2015; Rittel and Webber 1973; UN 2015), or they examine policy issue interdependencies without acknowledging how these are perceived and acted upon by policy actors (Jordan and Lenschow 2010). Perceptions of interdependency, such as awareness and perceived feasibility of acting, however, play a key role in determining how actors actually coordinate their actions across sectors and jurisdictions, Here, we argue that it is problematic to just assume that actors can successfully address interdependency in complex policy settings. Interrogating this assumption is important because studies of different types of interdependencies are gaining traction (Lade et al. 2020; Rocha et al. 2018; Weitz et al. 2018), and often imply that interdependency should be met or be resolved by collaboration. Yet in two empirical cases, Hedlund et al. (2021b) demonstrated that policy actors do not select partners for collaboration based on shared engagement with interdependent policy issues and a recent synthesis of studies on environmental governance similarly demonstrates that interdependencies certainly do not always instigate actors to collaborate (Bodin et al. 2019). Also, policy actors often weigh the priorities of their social network higher than integrated environmental solutions (Morrison 2007). New insights can thus be gained by empirically analysing policy actors' perceptions of policy issue interdependency, and asking if such perceptions may hinder or discourage actors from taking action aiming to address policy issue interdependencies. This is an important next step in our understanding of how collaborative environmental governance can effectively respond to complex environmental problems (Ansell and Gash 2008; Bodin 2017).

The emphasis on interdependency turns the spotlight on more complex relationships between policy actors, policy issues and their interdependencies. Such an elaborated perspective on a governance system is emphasised in the descriptions of 'networked action situations' (McGinnis 2011) and the 'ecology of games' (Lubell 2013; Lubell et al. 2010). Following these advances, recent research suggests that policy actors might select collaborative partners based on interdependent policy issues (Bodin and Nohrstedt 2016; Nohrstedt and Bodin 2020), although as stated above this certainly does not always apply. Nonetheless, policy actors seeking collaborating partners based on policy issue interdependencies would indicate an ambition to coordinate solutions across several policy issues and action situations. This emphasis of aligning choices of collaborating partners with policy issue interdependency builds from research on 'institutional fit' that underscores the benefit of governance structures to be aligned with the underlying nature of the environmental problem (Ekström and Young 2009; Galaz et al. 2008; Lebel et al. 2013; Young 2002).

Here, we ask whether and how different policy issue interdependencies affect policy actors' perception and collaboration. We depart from the abovementioned and somewhat puzzling observations of lack of collaboration over policy issue interdependencies (Bodin et al. 2019; Hedlund et al. 2021b) in formulating and empirically evaluating two propositions about actors' perceptions of policy issue interdependency. First, we examine whether the lack of collaboration can be explained by low awareness of policy issue interdependencies (proposition 1). Second, we examine whether actors that are aware of policy issue interdependencies nonetheless view them as infeasible to act upon (proposition 2). We differentiate, for both propositions, between two types of policy issue interdependencies – *reinforcing* (positive association with another policy issue) and *counteracting* (negative association with another policy issue) (Nilsson et al. 2016). Our propositions do not assume that collaboration over policy issue interdependencies cannot occur. Rather, they are deliberately posed to reflect some empirical observations, and to instigate an examination aiming to identify potential barriers for collaboration.

We test these propositions through a mixed-methods approach combining interviews, document analysis, and survey data with multilevel network analysis of actor and policy issue interdependencies. For collaboration, we apply an exploratory approach to test building blocks of actor and policy issue interdependencies. Our empirical case is the water governance of the Norrström basin, Sweden, where water flow crosses multiple water bodies within the larger drainage basin. The basin is managed through a highly polycentric structure where policy actors gather in a diverse set of collaborative venues such as water councils, interorganisational projects, intermunicipal platforms, or the River Basin District Authority. These venues are geographically bounded by the main task of managing different water bodies of the basin and carry out functions of governance such as social learning, coordination, and conflict resolution related to many specific policy issues. The venues include multiple actors that interact around one or several policy issues following certain procedures, and the venues are therefore suitable delineations for studying the alignment between collaborations of policy actors and interdependency of policy issues. In Norrström, degraded water status is a critical environmental problem (Water Information System Sweden 2020), addressed by local and regional policy issues

and policy actors. Still, whether and how efforts to address complex problems in water governance are understood by actors is often unclear (Moore 2013). Water governance in Norrström, therefore, constitutes a useful case-study setting for exploring actors' perceptions and collaboration in relation to policy issue interdependencies. We collected and analysed data in three steps. First, we conducted six in-depth informant interviews to gain an understanding of how actors perceived reinforcing and counteracting interdependencies. Second, we used social network data gathered through a survey with 35 policy actors in Norrström to construct Exponential Random Graph Models (ERGMs). ERGMs are specifically designed for statistical analyses of networks (Robins 2015) and account for the probability of observed ties to be dependent on the existence of other ties. Through these models, we examined if and how policy actors' selection of collaborative partners ('social tie formation') was based on reinforcing and counteracting interdependencies. Finally, we conducted six follow-up interviews to elaborate and validate our results.

Theory

Understanding policy issue interdependency

The 1987 Brundtland report *Our Common Future* (Brundtland Commission 1987) has been heralded as a global policy initiative for sustainable development and marked a transition away from fragmented, seemingly incompatible policy goals (Jordan and Lenschow 2010). The idea of integrating policy objectives to ensure sustainable development later inspired environmental policy integration (EPI) as an ordering principle for systematically connecting policy goals (ibid). In this way, EPI aimed early on to acknowledge policy issue interdependency, even though its success remains questioned (Persson et al. 2018; Runhaar et al. 2014). Policy issue interdependency is also a cogent argument in studies of correlating Sustainable Development Goals (Nilsson et al. 2016, 2018; Weitz et al. 2017). These studies go further in describing gradients of positive or negative types of interdependencies. Morrison et al. (2020) explain that 'Synergistic outcomes occur when one policy, law, or management intervention has a reinforcing effect on another, so that the combined outcomes exceed the individual effects.' From here on, we refer to *reinforcing* and *counteracting (policy issue) interdependencies* as possibilities to arrive at synergistic or adversary outcomes. We define reinforcing interdependencies as when two policy issues become positively correlated through a common, intervening factor (e.g. implementation of phosphorus dams and buffer zones both reducing leakage from land-based production). We refer to counteracting interdependencies as negative correlations between two policy issues, meaning that actions to address one policy issue have negative consequences for the other policy issue (e.g. increasing hydropower by building new dams challenging the maintenance of fish connectivity that implies removing dams).

However, much traditional policy research treats problems as conglomerates, or simply characterises problems as complex or wicked (Head 2019; Head and Alford 2015; Moon 2020; Rittel and Webber 1973). Such sweeping depictions of policy problems cloud our understanding of the role and impact of interdependency in policy-making. While the partitioning of environmental problems into policy issues may cause fragmentation between governance units, recent research suggests that this perspective can feed the development of theory about governance effectiveness (Bodin and Nohrstedt 2016; Hamilton et al. 2019; McGlashan et al. 2019; Metz et al. 2020; Nohrstedt and Bodin 2020). Any given environmental problem is typically framed by one or several environmental targets. For example, the problem of water contamination can instigate creating targets such as improving water quality. Policy issues, in turn, are often formulated to meet these targets through several actions or events (*intervening factors,* (Hamilton et al. 2019; Hedlund et al. 2021a). Intervening factors, as defined here, are socio-economic or biophysical-oriented causal steps that policy issues depend on to meet their desired targets, and hence, policy actors must address them (although we acknowledge that causality is rarely fully adhering to simple 'flow charts'). Technically, *policy issue interdependency* emerges indirectly when two policy issues link to common, intervening factor(s) in the relationships between policy issues and their targets (Hedlund et al. 2021a). The correlated policy issues may thereby create a combined effect (i.e. any actions directed towards the intervening factor entail implications for both policy issues). Still, most current analyses of policy issue interdependency do not relate it to policy actors' perception and response, or lack thereof.

Policy actors' perceived effectiveness of a good alignment between collaboration and policy issue interdependencies (a perceived 'institutional fit', Bodin 2017; Lebel et al. 2013; Lubell et al. 2010; Young 2002) may vary with transaction costs (Ostrom 2005; Feiock 2013; Lubell et al. 2017). Here, reinforcing and counteracting interdependencies constitute profoundly contrasting reference points. Reinforcing interdependencies involve the potential for gains (a win–win) when addressing two interdependent issues in an integrated fashion. Gains imply greater ease to achieve goals, such as the implementation of solutions that meet environmental objectives adhering to more than one policy issue. This implies that actors could benefit from what other actors addressing interdependent policy issues are doing, albeit it also carries an assumption that realising these gains hinges upon actors' ability to coordinate their actions. Thus, the gains they could

achieve if coordinating their activities to strengthen their impact is assumed to be easily acquired. Even though counteracting policy issues are not necessarily zero-sum games, they may entail a lower likelihood for actors engaged in these policy issues to receive benefits from their efforts, if measures targeted to enhance the other policy issue are simultaneously applied. Particularly, an actor's ability to receive any gains (or minimise losses) from its own actions depends on other actors' actions (cf. prisoner's dilemma). Nonetheless, conceptually similar as when considering reinforcing interdependencies, any two actors could potentially gain from collaboration, if they could find ways to balance counteracting interdependencies in mutually agreeable ways. Next, we consult previous theory to formulate two propositions about how actors perceive and assess policy issue interdependencies.

Propositions on why policy actors might not collaborate on policy issue interdependencies

Policy actors' awareness of existing policy issue interdependencies constitutes an important pre-condition for instigating actions that can successfully address such interdependencies. Yet environmental problems, and their policy issue interdependencies, are often perceived as highly complex and sometimes intractable (DeFries and Nagendra 2017). Thus, policy actors may not discern detailed interdependencies. Policy actors may also not be cognizant of policy issue interdependencies if these are not visible in the policy process (Haas 1992).

Counteracting interdependencies may sometimes be negatively framed compared to reinforcing interdependencies, and might therefore be downplayed and less observable for actors (Daw et al. 2015; Schoemaker and Tetlock 2012). A high number of intervening factors can also hide interdependencies for policy actors. Hamilton et al. (2019) demonstrated that awareness about counteracting interdependencies was low when many intervening factors created a 'lagged' distance between an action and its outcome, making interdependencies harder to discern. Another study similarly showed that counteracting interdependencies had more intervening factors than reinforcing interdependencies (Hedlund et al. 2021a), potentially complicating awareness (we however acknowledge that this assumption might not be relevant in another setting). These different characteristics of reinforcing and counteracting interdependencies may skew policy actors' awareness about them. Conclusively, actors may not be equally aware of reinforcing and counteracting interdependencies. If counteracting interdependencies are less emphasised and additionally linked to more intervening factors than reinforcing, they may also be harder to perceive. Based on these insights, we formulate a first proposition to explain why collaboration related to policy issue interdependencies may not occur: *policy actors have, in general, low awareness of policy issue interdependencies, and they have lower awareness of counteracting than of reinforcing policy issue interdependencies.*

Actors' responses to policy issue interdependencies also depend on their perception of what is 'politically feasible'. Such feasibility here refers to the intricacy of the policy-making process and reflects how the 'slighting of political implications' can hinder responses to policy issues (May 1986; Meltsner 1972). Political feasibility is thus tightly linked to the perceived costs and gains inherent to different policy issues. Perceived infeasibility, i.e. higher costs than gains, may stem from many factors (Peters 2018). Actors may, for example, believe that other actors have low interest or low capacity to collaborate. Conflict among stakeholders (due to divergent beliefs) can be another factor (Weible 2007). Institutional structures and procedures can also be hindering action regarding policy issue interdependencies (Lubell 2004), for example, if formal responsibility and jurisdictional mandates are diffuse or even contradictory. Overly rigid rules or delimiting jurisdictions can trigger a perceived infeasibility to act upon policy issue interdependencies (Oberthür and Gehring 2006). When the costs of acting overweigh foreseeable gains, policy issue interdependencies are likely to be perceived as infeasible to act upon. In contrast, collaborative institutions and network governance, i.e. governance arrangements where actors are prompted to collaborate with relevant others, might lower transaction costs and increase perceived feasibility to act on policy issue interdependencies (Feiock 2013). Collaborative networks may include more discretion, or informal rules-in-use (Ostrom 1999), under which circumstances actors' perceptions of policy-making often become more important than the design of governance mechanisms itself (Morrison et al. 2019). Despite the potential benefits of collaborative networks to increase the feasibility of acting on policy issue interdependencies and lower costs, Lubell et al. (2010) hold that actors often prioritise individual 'games' (i.e. engagements in issues) and that few institutional mechanisms exist to coordinate across policy issues. Since reinforcing and counteracting interdependencies likely involve different levels of costs and gains, perceived feasibility may also differ depending on the type of interdependency. A second proposition to explain lack of collaboration over policy issue interdependencies, that partly presupposes a falsification of the first proposition regarding low awareness, is, therefore, that *policy actors experience perceived infeasibility of responding to policy issue interdependencies and the perceived infeasibility is not necessarily the same for counteracting as for reinforcing interdependencies.*

A general expectation might be that collaboration over reinforcing interdependencies will be prominent due to the possible gains actors could acquire if working together. Yet in the case of 163 interactions between international and European Union (EU) environmental governance institutions, a majority of counteracting ('disruptive') interaction received a collective political response,[1] whereas roughly 80 percent of the reinforcing interactions were not responded to (Oberthür and Gehring 2006). The authors speculated that actors involved in counteracting interdependencies might be aggrieved and desire change, whereas reinforcing interdependencies more easily become 'consumed', aborting further action regardless of any remaining potential in improving outcomes. Aversion to potential loss overshadowing desire to harvest potential gains may also opt for a stronger response to counteracting interdependencies (Kahneman and Tversky 1979; Thaler et al. 1997; Tversky and Kahneman 1991). Moreover, since counteracting interdependencies involve a possible 'winner-loser' outcome, they can instigate open conflict thereby causing a lack of collaboration, whereas the opposite may occur if the actors perceive that collaboration is the most feasible way to address the situation (Bodin et al. 2020). Furthermore, if policy actors expect their chances of gaining are high, they would not find utility in collaboration (cf. if actors have a favorable position over others in achieving their own goals, they might find collaboration risky since potential compromises can leave them in a less favorable position; Fischer 2014). In summary, previous studies provide partly conflicting evidence about whether reinforcing or counteracting interdependencies would exert the strongest pressure on actors to engage in collaboration. We thus refrain from proposing one over the other but maintain that collaboration could vary since policy actors weigh the transaction costs associated with reinforcing and counteracting interdependencies differently.

Methods

Empirical case

The Norrström drainage basin, situated in Mideast Sweden, comprises a high number of policy actors connected through the present water governance engagement that implements the EU Water Framework Directive (WFD). Its territorial scope, covering 1,214 lakes, streams and coastal waters in an area of 22 650 km^2, more than 3 million people (Statistics Sweden 2019) and a multitude of challenges connected to the overall policy topic of water governance, together represents a policy subsystem within the Swedish political system (Jenkins-Smith et al. 2017). This subsystem includes collaborative venues of varying size and roles, but common for all is their aspiration to gather a high diversity of policy actors and to jointly engage in relevant policy issues in the water governance of Norrström. Since many different societal activities depend on access to clean and reliable water flows (e.g. agriculture, drinking water supply, energy production, biodiversity in streams, wetlands and forests, etc.), individual policy actors most often engage in not one but several policy issues within the water governance domain (Brandenberger el al. 2020).

Selecting appropriate respondents and collaborative venues

First, to gather data on policy issues and targets, we conducted a first round of exploratory interviews with six participants (combined with participatory observation and text analysis of policy documents mainly produced by the regional River Basin District Authority and the collaborative venues in the Norrström basin). We included six actors across a broader set of venue types from different geographical and administrative areas of the Norrström basin to inquire about what policy issues they engaged in, and what targets these issues were set to address.

Second, we selected the largest water council, Mälarens vattenvårdsförbund (MVVF), as a case to study actors' collaboration in response to policy issue interdependency. MVVF is decentralised in its structure and includes a diversity of actors, but is mainly dominated by politicians and civil servants from different municipalities and country administrative boards across Lake Mälaren.

Last, we selected six respondents for follow-up interviews. While the first set of respondents had been chosen to represent the geographical and substantial diversity of the policy subsystem, ensuring a breadth of identified policy issues, the second sample was chosen by their deep expertise and long experience of water governance in Norrström. These in-depth interviews aimed at capturing perceptions of policy issue interdependency, and to validate our modelling. We identified individuals based on their prior participation in previous data collection efforts (Hedlund et al. 2021b), and based on their relevant positions in respective organisations and collaborative venues. Four of these respondents had completed survey data earlier and two had taken part in the first interview round. We also interviewed a researcher in hydrology with experience about Norrström that had not participated in previous data collection, yet who added a scientific perspective.

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[1] Reported as 'communication between institutions'.

Table 1 Policy issues in the Norrström basin

Policy issues
Environmental monitoring of non-native species
Regulation and distribution of water flow
Maintaining fish connectivity
Protection of cultural heritage
Ecological restoration of meandering watercourses
Climate change adaptation
Construction of wetlands
Sustainable storm water management
Implementation of phosphorus dams
Implementation of buffer zones
Implementation of lime treatment
Implementation of private sewage
Environmental monitoring of water quality and recipients
Upstream regulation by the source
Treatment of benthic sediment
Managing invasive species

Reproduced from Hedlund et al. (2021a, b)

Eliciting policy issues and policy issue interdependencies

Identifying policy issues and policy issue networks

Our definition of policy issues lies close to specific measures and possible solutions that may be taken to address environmental targets. Their interdependencies thereby differ from purely biophysical interdependencies by defining what opportunities exist for joint action, rather than describing characteristics of the environment (even though biophysical interdependencies often give rise to policy issue interdependencies). Policy issues and their interdependencies were identified based on the methodological procedure developed in Hedlund et al. (2021a), which is summarised here. First, we identified a list of policy issues and a list of targets through qualitative data triangulation based on (i) participant observation of attendees at two regional (within the Norrström district) and one national meeting targeting challenges in water governance; (ii) text analysis of policy documents mainly produced by the regional River Basin District Authority and the collaborative venues in the Norrström district; and (iii) (first round) exploratory interviews inquiring about the main policy issues and targets in the water governance of the basin with six expert practitioners holding a coordinating role in either the River Basin District Authority or in a collaborative venue. The list of policy issues is included in Table 1. Second, we used the Miradi Open Standards tool (www.miradi.org) to map causal pathways between each identified policy issue and its target, representing the relationship between them. These

pathways included intervening factors required to meet a certain target and the positive and negative connections (i.e. steps, or 'paths' in network terminology) between them. For example, effectively reducing water pollution (target) could involve devising rules against ditching (intervening factor) since fewer ditches can decrease agricultural runoffs (policy issue one), but reducing ditching could also prevent the loss of wetlands (policy issue two). Relying on the set categorisation of intervening factors developed by Miradi, we mapped three types of intervening factors between policy issues and targets: *biophysical stressors* (factors that directly impair environmental targets), *direct threats* (human activities that immediately affect the biophysical stressors), and *indirect, contributing factors* (any other factors in-between the policy issue and the direct threats, typically related to various socioeconomic and institutional characteristics of the study system, or human-induced actions and events). Multiple policy issues could be connected to the same intervening factor if they all relied on this factor to meet their target. We mapped an overall diagram of pathways and identified common, intervening factors connecting two or several pathways. We modelled policy issue interdependencies by identifying two policy issues having a common intervening factor in their respective pathway to their target. The total number of steps from two policy issues to the common factor, i.e. the path length, is here referred to as the distance to the common intervening factor. The shortest possible distance was two (one for each policy issue to the common factor), and in our case, the maximum distance turned out to be eight steps. Third, we modelled four policy issue networks where the 16 policy issues represented nodes in the policy issue network, and the links between two policy issues given their common, intervening factor represented ties. By applying different thresholds in the modelling process, a restrictive threshold (one-factor type: only *indirect, contributing factor*) produced a sparse network, while applying increasingly inclusive thresholds by adding more factor types produced denser networks. Since variation in the network is a precondition for analysing the underlying drivers behind the formation of actor ties, we used the most restrictive network (i.e. sparsest network including only one common factor type, the indirect factor) for our analysis.

Identifying reinforcing or counteracting policy issue interdependencies

The relationships between intervening factors are either positive or negative, where positive implies that one factor one-directionally amplifies another, and negative implies a reduction. We describe a *reinforcing effect* as emerging when two policy issues both have only positive or an even number of negative relations to a common, intervening factor (Fig. 1). An odd number of negative relations to the common factor
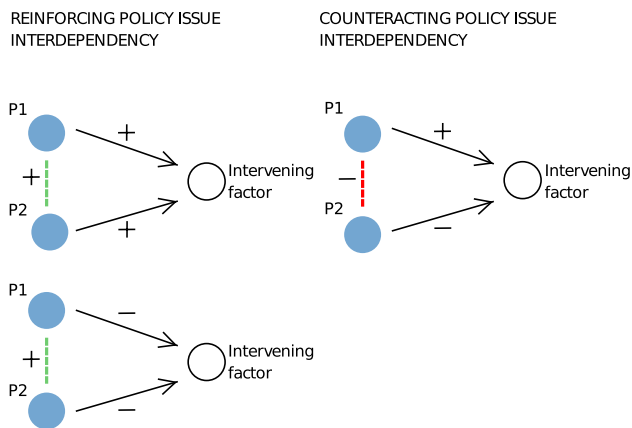
Fig. 1 Reinforcing interdependencies, created from an even number of positive or negative steps to a common, intervening factor, and counteracting interdependencies, created from an odd number of negative steps to the common, intervening factor

gives a *counteracting effect* to a given policy issue interdependency. We, therefore, produced separate policy issue networks of reinforcing interdependencies and counteracting interdependencies.

Eliciting perception of reinforcing and counteracting interdependencies

We conducted a second round of interviews that would complement our network models with qualitative information on the perception of policy issue interdependencies. We interviewed six respondents between January and March 2020. The interviews followed semi-structured protocols (Appendix A1), and focused on (1) actors' awareness of reinforcing versus counteracting interdependencies (2) perceived feasibility of acting on reinforcing versus counteracting interdependencies and (3) the results of the network modelling. Every interview session occurred between sixty to ninety minutes. Before the interview, the respondents received a preparatory e-mail listing the definitions of a policy issue, a reinforcing and a counteracting interdependency, along with the list of the 16 identified issues and two diagrams exemplifying each type of policy issue interdependencies, derived from our previous mapping (Hedlund et al. 2021a).

To validate our mapped policy issue interdependencies, we used the two exemplifying diagrams sent to respondents before the interview (Appendix A1). The interviews were transcribed, coded in primary and secondary cycles (Tracy 2013) in MAXQDA and cross-analysed by comparing responses across each block and question in the protocol. First, we coded responses by each question, following the question protocol. Second, we coded more detailed segments describing reinforcing and counteracting interdependencies, and for agreement or disagreement with other interviews.

In this way, we could discern similarities and differences in respondents' views, and if and how these varied between reinforcing and counteracting interdependencies.

Eliciting collaboration over reinforcing and counteracting interdependencies
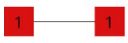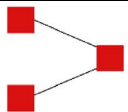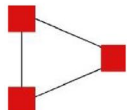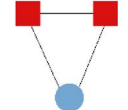
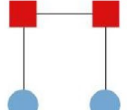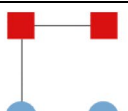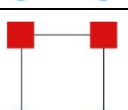### Actor and actor-issue networks
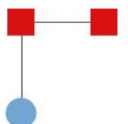
Data on policy issue engagement and actor networks in the water council MVVF were collected through a web-based survey. Contrary to our smaller selection of interview respondents, we were interested in a larger sample size for a broader understanding of actors' choice of partner. The survey was therefore sent out to 47 respondents in MVVF (response rate 74%). We obtained a list from the council secretary of all members holding an operational role. An 'operational role' signified that they were either a member of the council board or a working group. The respondents received a postal letter informing them about the survey before the e-mail invitation ('the tailored-design method', Dillman et al. 2014).

For actor-issue ties, respondents were presented with the list of 16 policy issues identified in the qualitative data triangulation and asked to specify their engagement in each of the 16 policy issues to a 'high level', 'moderate', 'little', 'don't know', or leave a blank to indicate no engagement. For actor ties, we presented the respondents with a predefined list of the individual policy actors in MVVF and asked them to fill in with whom they collaborate over *information-sharing* and/or *co-organising of activities*. We specified collaboration as 'regular professional contacts with whom you aim to share information and/or co-organise activities', and asked to specify their answer as 'high level', 'moderate', 'little', or leave the name blank to indicate no collaboration with any given individual. More answers were recorded for information-sharing, and we therefore used this data to define actor ties. Combined with the data on policy issue interdependencies, the data collected on actor and actor-issue ties served as input for creating the multilevel network.

Multilevel exponential random graph models

We proceeded by the following process when modelling the multilevel network. In the actor network, we only included actor ties that were specified as 'high level' or 'moderate' collaboration. Likewise, we only included ties specified to 'high level' or 'moderate' policy issue engagement in the actor-issue network. We considered the policy issue network and the actor-issue network to be fixed, i.e. we assumed that policy issue interdependencies remain static and that actors cannot choose their policy issue engagement as freely as they choose collaborative partners. While we recognise

Table 2 Network building blocks for the ERGMs

Network configuration	Process and ERGM terminology
	Activity. The tendency of actors with specific attributes to have more ties. (ActivityA)
	Homophily. The tendency of actors to form social ties with others based on them having the same attribute. (interactionA)
	Centrality and activity effect. The tendency of an actor to become more socially active based on its existing ties to other actors. (Star2A)
	Transitivity. The tendency of two actors to form a tie when being socially connected to the same common actor. (ATA)
	Social activity deriving from policy issue engagements. The tendency of an actor to become more socially active based on his or her engagement in policy issues. (Star2AX)
	Shared policy issue closure. The tendency of actors engaged in the same policy issue to form a social tie. (TriangleXAX)
	Homophily among actors engaged in policy issues. The tendency of actors engaged in policy issues to form ties with other actors that are also engaged in policy issues (if policy issues are interdependent or not is not assumed to have an effect here). (L3XAX)
	Activity through engagement in interdependent policy issues. The tendency of actors to become more active when engaged in (reinforcing or counteracting) policy issue interdependencies. (L3AXB)
	Interdependent actor- and policy issue closure. The tendency of actors to form social ties with other actors engaged in the same (reinforcing or counteracting) policy issue interdependencies. (C4AXB)

Red squares represent policy actors and blue circles represent policy issues. Reproduced from Hedlund et al. (2021b)

that this might simplify reality (interviews indicated that choice of issue is often a mix between organisational mission, need and personal interest), we nonetheless maintain that the choices of collaborating partners are less constrained than choices of policy issues. More slowly-changing factors such as educational background, professional competencies, and formal organisational responsibilities strongly influence which policy issues a given actor are to engage with. Hence, we assume the effective time frames of the processes influencing the choices of partners and issues to differ, where the former time frame is assumed to be shorter and occurring after the latter (thereby justifying treating actor-issue relationships as static while treating social ties as dynamic). Subsequent results (presented below) support this assumption.

We used network building blocks (Table 2; Bodin and Tengö 2012) to configure ERGMs for the reinforcing and counteracting issue networks respectively. There is limited empirical knowledge about policy issues and policy issue interdependencies as drivers of social tie formation; hence, we selected building blocks based on a largely exploratory approach and scant previous studies (Hedlund et al. 2021b). Since reinforcing interdependencies were overrepresented in the sparsest network, we additionally tested more 'generous' policy issue networks (i.e. including more intervening factors, which in turn meant that more policy issue interdependencies are included in the network) to compensate for, all things equal, the lower number of counteracting interdependencies.

Results

Policy actors' awareness of and feasibility to act upon reinforcing interdependencies

Four of the six respondents, at first glance, questioned the exemplified reinforcing interdependency. Yet, all respondents indicated connections between the two issues, such as 'they both aim to improve the water quality', 'they address the same environmental problem', 'they both require allocation of land', 'one reduces the need for the other' or 'an interest in one gives an interest in another'. Hence, all respondents, in fact, referred to an interdependent relationship between the exemplified policy issues. Several respondents also exemplified other reinforcing interdependencies that we had identified before following our procedure outlined above. In this sense, the respondents corroborated the existence of reinforcing interdependencies.

Most respondents, however, expressed that the exemplified policy issues were uncoordinated, i.e. that they were in practice addressed independently. This indicates that while the existence of interdependencies could be verified, several respondents expressed that the exemplified reinforcing interdependency disagreed with how they work and/or what they perceive as feasible to act upon. This divide signifies that, possibly, respondents initially described the issues as independent since they associated the interdependency with uncoordinated working procedures. This reveals that policy issues are often not coordinated through working procedures a priori. Still, respondents claimed that they initially identify what policy issues to work with, and subsequently seek collaborative partners on that basis. Three respondents argued that a broad collaborative network enables, as a second step, the identification of previously unknown reinforcing interdependencies. This signals that reinforcing interdependencies have the potential to be feasibly addressed through collaboration despite the reported lack of coordination across reinforcing policy issues.

Policy actors' awareness of and feasibility to act upon counteracting interdependencies

All respondents expressed awareness about the counteracting interdependency, but respondents also argued that the exemplified counteracting effect could be reversed into reinforcing depending on how solutions are implemented in practice. As one policy actor expressed 'there are different nuances to it, they [counteracting interdependencies] are not always so black and white'. This is another salient example of how policy actors derive their perception of interdependencies from how they work with them in practice, rather than the basic conditions that create interdependency. Possible solutions were exemplified as mainly technical or legal, indicating the counteracting interdependency as feasible to address. However, the respondents reported that they, overall, relied on jurisdictional procedures for managing counteracting interdependencies. In contrast to reinforcing interdependencies, counteracting interdependencies are thus addressed through the judgement by a court, state reviews and formal regulations. This suggests that policy actors prefer to deal with a win-lose situation by other means than engaging in direct collaboration with other actors, possibly due to the risk of open conflict as they start to collaborate with others that might have different and opposing objectives.

Collaborative responses to reinforcing interdependencies

To study collaboration between all studied actors, we complemented our interviews by statistically analysing tie formation based on reinforcing and counteracting interdependencies. Our ERGM results for MVVF indicate that actors consider reinforcing interdependencies in their selection of collaborative partners (Table 3). Actors engaged in addressing issues that are relatively often reinforcing other issues tend to have more collaborative partners than others (positive L3AXB). Actors, however, tend to avoid collaborating when both actors are engaged in policy issues that are in turn also reinforcing each other (negative C4AXB). This is contrary to the presumption that collaboration over reinforcing interdependencies would be easily incentivised through a win–win, all else being equal. Overall, these results demonstrate that when actors choose collaborative partners, reinforcing interdependencies are considered – although not exactly as expected from the interviews and from the assumption that actors univocally strive towards enhancing institutional fit.

Finally, we observe that actors tend to collaborate if they are addressing the same policy issue (TriangleXAX). This corroborates the interviews where the respondents stated that after they have decided which issues to address, they look for collaborators based on those choices.

Collaborative responses to counteracting interdependencies

Actors do not consider counteracting interdependencies in their choice of partner (Table 4; C4AXB), nor do they weigh in these interdependencies in their choice of partners in any other way either. A sensitivity analysis (Appendix A3) confirmed that these results hold when investigating counteracting interdependencies that emerge from two types of intervening factors (i.e. considering a broader set of counteracting interdependencies). Thus, the lack of significant

Table 3 Model for reinforcing interdependencies in MVVF

Effects	Parameter	Estimated standard errors	t-ratio (good model convergence if < 0.2)
Activity (the tendency of chairs to have more ties) (*chair_activityA*)	2.0363*	0.582	− 0.022
Activity (the tendency of politicians to have more ties) (*politicians_activityA*)	0.0125	0.342	− 0.044
Homophily (the tendency of politicians to form social ties with other politicians) (*politicians_interactionA*)	1.1926	0.696	− 0.016
Homophily (the tendency of civil servants to form social ties with other civil servants) (*civil servants_interactionA*)	1.2521*	0.383	0.056
Centrality and activity effect (*Star2A*)	0.0602	0.042	0.015
Transitivity (*ATA*)	0.3761	0.201	0.022
Social activity deriving from policy issue engagements (Star2AX)	− 0.2069	0.108	0.049
Shared policy issue closure (*TriangleXAX*)	0.7688*	0.3	0.071
Homophily among actors engaged in policy issues (*L3XAX*)	0.0007	0.034	0.046
Activity through engagement in interdependent policy issues (*L3AXB*)	0.143*	0.049	0.053
Interdependent actor- and policy issue closure (*C4AXB*)	− 0.4888*	0.156	0.06

Model names are given within parenthesis. Parameter estimates are significant if the absolute parameter value is greater than twice the size of the standard error. Goodness of fit is provided in Appendix A2

Table 4 ERGM results for counteracting interdependencies

Effects	Parameter	Estimated standard errors	t-ratio (good model convergence if < 0.2)
Activity (the tendency of chairs to have more ties) (*chair_activityA*)	2.0479*	0.575	0.02
Activity (the tendency of politicians to have more ties) (*politicians_activityA*)	0.0406	0.339	0.058
Homophily (the tendency of politicians to form social ties with other politicians) (*politicians_interactionA*)	1.214	0.683	0.093
Homophily (the tendency of civil servants to form social ties with other civil servants) (*civil servants_interactionA*)	1.2357*	0.388	− 0.022
Centrality and activity effect (*Star2A*)	0.0625	0.04	0.026
Transitivity (*ATA*)	0.361	0.203	0.046
Social activity deriving from policy issue engagements (Star2AX)	0.008	0.076	0.016
Shared policy issue closure (*TriangleXAX*)	0.5384*	0.252	− 0.017
Homophily among actors engaged in policy issues (*L3XAX*)	− 0.0365	0.03	− 0.022
Activity through engagement in interdependent policy issues (*L3AXB*)	0.0534	0.049	0.026
Interdependent actor- and policy issue closure (*C4AXB*)	− 0.1109	0.128	− 0.011

Model names are given within parenthesis. Parameter estimates are significant if the absolute parameter value is greater than twice the size of the standard error. Goodness of fit is provided in Appendix A2

effects did not result from the relatively fewer counteracting interdependencies as compared to the reinforcing ones.

Explaining network modelling results

Table 5 and Fig. 2 summarise the results from the network modelling results and our second round of interviews. In the second interview round, we also followed up the network modelling results by asking respondents why, potentially, actors would not collaborate based on reinforcing interdependencies. Reasons mentioned were inexperience or unfamiliarity with other policy issues, the need to prioritise urgent or simple policy issues, 'silo-isation', having insufficient financial resources, low awareness of reinforcing interdependencies, risks that reinforcing interdependencies turn into counteracting interdependencies

Table 5 Results from interviews and network analysis

Reinforcing policy issue interdependencies	
P1: Awareness	**P2: Feasibility**
Interviews: Actors have awareness of reinforcing interdependencies. This assessment is however partly blurred by, on one hand, actors' agreement about the common driver of the interdependency, but on the other hand, their disagreement that it represents a synergetic opportunity, suggesting perceived infeasibility (see right)	Interviews: Actors deem reinforcing interdependencies feasible to act on, but barriers (uncoordinated working procedures) still indicate infeasibility to address interdependencies through collaboration
Model: Actors consider reinforcing interdependencies, which supports actors' awareness of interdependencies	Model: Actors consider reinforcing interdependencies, yet tend to avoid collaborating on them, which indicates infeasibility. It also suggests that these infeasibilities reduce the likelihood that actors would collaborate regardless of whatever intentions they have when instigating a collaborative tie
Interviews and network modelling both support actors' awareness of reinforcing interdependencies	Interviews and network modelling both support infeasibility to address reinforcing interdependencies through collaboration, and this deficit might be due to procedural and institutional barriers

Counteracting policy issue interdependencies	
P1: Awareness	**P2: Feasibility**
Interviews: Actors have awareness about counteracting interdependencies	Interviews: Actors deem counteracting interdependencies infeasible through collaboration (but feasible through legal procedures)
Model: No consideration of counteracting interdependencies, which suggests low awareness of such interdependencies	Model: No consideration of counteracting interdependencies, which would indicate that counteracting interdependencies are infeasible to act upon (but this finding could also be explained by low awareness)
Interviews and network modelling counter each other concerning actors' awareness of counteracting interdependencies. Interviews support awareness of interdependencies, yet the lack of response in the network model indicates low awareness	Interviews and network modelling counter each other concerning actors' infeasibility of counteracting interdependencies. By weighing both the interviews and the model, we suggest that lack of awareness and infeasibility both add to the observed lack of consideration of counteracting interdependencies

Fig. 2 Interpretation of results for propositions 1 and 2. Red boxes indicate that we find the strongest support for infeasibility of acting upon reinforcing interdependencies, while there may be both low awareness and infeasibility of acting upon counteracting interdependencies
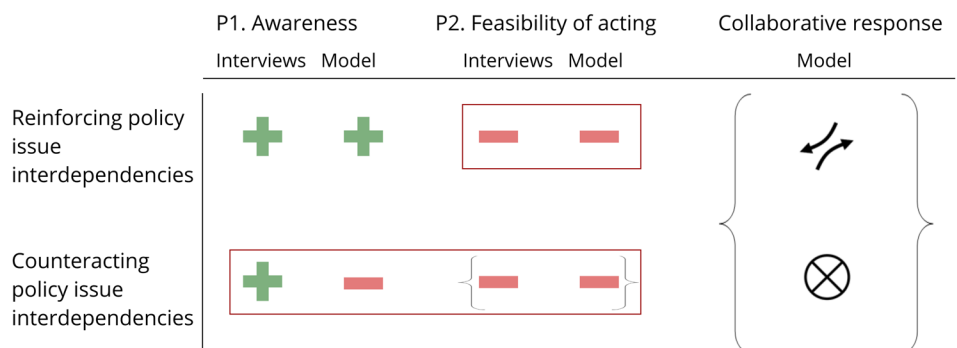
(which indicates that a reinforcing interdependency can also be reversed into counteracting through difficulties in the process), that potential gains from reinforcing interdependencies could be serving someone else, time constraints, non-matching personalities and lack of personal relation.

Discussion

This article identifies two knowledge gaps about policy actors' realities in relation to complex environmental problems. First, while literature has described reinforcing and counteracting policy issue interdependencies, the

relation between forms of interdependency and policy actors' responses remains underexplored. Second, previous studies found a lack of collaboration over policy issue interdependencies in our case-study setting. Still, research has not investigated the contrast between reinforcing and counteracting interdependencies as potential explanations for this behaviour.

Policy actors' awareness, perceived feasibility and collaboration in relation to policy issue interdependencies

Based on interviews and network modelling (Table 5) we find only little support for proposition 1, which predicts that lack of collaboration over policy issue interdependencies can be explained by low awareness among actors. Instead, we show that actors are aware of both reinforcing and counteracting interdependencies. Lack of collaboration cannot solely be attributed to low awareness among actors of policy issue interdependencies. Our interviews showed that actors recognised the existence of reinforcing interdependencies through their identification of common, intervening factors. The network modelling showed that actors tend to not engage in collaboration based on reinforcing interdependencies. This result implies that actors are aware that reinforcing interdependencies exist. The interviews indicated that actors identify counteracting interdependencies, yet the network modelling showed that actors do not consider them. This could suggest low awareness, which would support similar findings by Hamilton et al. (2019), but in our case this lack of consideration could also be explained by perceived infeasibility to effectively address counteracting interdependencies as we elaborate below.

Proposition 2 predicts that policy actors find it infeasible to respond to policy issue interdependencies by collaboration, yet that perceived infeasibility may differ depending on interdependency type. We find support for perceived infeasibility related to both reinforcing and counteracting interdependencies, yet deriving from two different reasons. Interview respondents claimed that counteracting interdependencies are feasible to address through water-rights judgements in court, but generally not through collaboration. Reliance on legal procedures to decide on 'win-lose' outcomes indicates that counteracting interdependencies are often handled formally, without collaboration. This interpretation is corroborated by the network analysis, which suggested that actors did not consider counteracting interdependencies when choosing collaborative partners, neither as a factor that would instigate them to collaborate, nor as a factor that would prevent them from collaborating. This could, however, be explained by both low awareness and infeasibility to act. It is difficult to single out one of the causes. On the one hand, the interviews support existing awareness of counteracting interdependencies and therefore prompt infeasibility as a stronger explanation. On the other hand, the network modelling results are, however, also compatible with the interpretation that actors are not aware of these counteracting interdependencies. These seemingly contradicting results do not suggest that the results are incompatible, rather, they suggest the lack of consideration of counteracting interdependencies could be a mixture of both lack of awareness and perceived infeasibility. Results from the interviews are also based on a selected subset of actors and may, therefore, not be representative for all actors included in the network analysis. It could be that a sizeable proportion of the actors do not perceive the counteracting interdependencies as well as the interviewees. Nevertheless, our triangulation approach (combining interviews and network data) shows that questions remain, while also suggesting that there are several factors that contribute to lack of collaboration on counteracting interdependencies.

Our network results indicate that actors act on reinforcing interdependencies, but that various barriers in their current working procedures make the actors prone to avoid collaborating with others that are also working directly with reinforcing policy issues. On one hand, these interdependencies are not only infeasible to act upon through collaboration, they even act as barriers for collaboration. On the other hand, reinforcing interdependences led to other collaborative preferences, such as the propensity of actors working with policy issues that had many reinforcing interdependencies to have many collaborative partners.

These analyses confirm that policy actors' choice of collaborating partners in relation to reinforcing versus counteracting interdependencies differ. Actors acknowledge reinforcing interdependencies more strongly compared to counteracting interdependencies, but not as we expected. Instead, actors avoid collaboration on reinforcing interdependencies, a scenario implicated by previous research (Bodin et al. 2019; Hedlund et al. 2021b). Reinforcing interdependency thus appears to be a stronger explanation than counteracting interdependency to lack of collaboration. This result neither supports nor counters the idea that counteracting interdependencies would be prioritised due to higher perceived risk aversion (Oberthür and Gehring 2006), since counteracting interdependencies were not considered at all as a basis for collaboration. Rather, the findings indicate support for previous theoretical claims that collaboration may not be rewarded by the political, economic, and administrative incentives that allow for coordination (Lubell 2004), and that the institutional structure, therefore, has a strong hold on perceptions of higher costs than gains.

Our results indicated some reasons for the lack of collaboration over reinforcing interdependencies. Collaboration appears to be lacking when the uncertainty of gains from reinforcing interdependencies is too high. Factors stated in

the follow-up interviews ('silo-isation', inexperience with other issues, lack of personal relations) indicate that this uncertainty might be triggered by perceived infeasibility and collaborative risk. Evidently, actors must commit deeply in collaboration to benefit from a win–win. High commitment may impose a higher perceived risk among actors, and make them reluctant to collaborate over directly reinforcing policy issues (versus counteracting). Instead, actors focus on shared policy issues (TriangleAXA in Tables 3 and 4) which imply a lower risk through coordination over a single issue. In other words, the persistence of silos that demand high commitment to achieve any benefits from collaboration might devalue gains from a reinforcing interdependency. Actors prefer to minimise losses over maximising gains (Tversky and Kahneman 1991), and therefore, they may become averse to the risk of engaging in collaboration with uncertain gains. This can be seen as a myopic type of decision-making (Benartzi and Thaler 1995) since it means that possible gains for the environmental problem are deprioritised for the benefit of not having to make risky choices.

In terms of potential generalisation of findings, our case involves participating actors that are relatively free to decide on what to do, and with whom, for a given watershed. Results may, therefore, vary along this dimension. For example, if actors' choice of collaborative partners is less free and instead steered on the basis of integrating certain policy issues, there is a chance that collaboration on interdependent policy issues would be more frequent than in our case. A limitation of our approach may be that in cases with more steered collaboration, actors' choice of partners may not provide an indication of the degree to which they perceive or consider policy issue interdependencies. A recommendation for future research would therefore be to study whether collaboration on interdependent policy issues is higher in such cases, yet separate the foci on perception and collaboration.

Conclusion

This article investigates whether and how differences between reinforcing and counteracting policy issue interdependencies can help explain actors' lack of collaboration in environmental policy settings. We make two contributions to the literature on policy issue interdependency. First, we disaggregate a complex environmental problem into observable reinforcing and counteracting interdependencies. Second, we connect policy issue interdependencies to actors' perceptions and engagement in collaboration by elaborating and testing propositions about awareness and perceived feasibility. We set out arguing it is problematic to just assume that actors are able to act upon interdependency in complex policy settings, and our in-depth

examination of actors' perceptions of and collaboration around reinforcing and counteracting interdependencies empirically confirm that responding to interdependencies is not always feasible for actors. Our empirical findings from the Norrström basin thereby contribute to advancing theory on collaborative approaches to complex environmental problems, particularly what may hinder actors' responses to policy issue interdependencies.

While our assumptions underpinning the propositions assume rationality (if actors are aware of policy issue interdependencies and consider them feasible to act upon, they can be expected to collaborate), our results suggest that actors' decision-making may not always be this straightforward (Moore 2013). For example, social capital can be present but not mobilised for the type of actions that one might expect (Bodin and Crona 2009; March 1994) or actors may be driven by insecurity and uncertainty. Hence, future studies should continue to explore other factors that may hamper responses to policy issue interdependencies.

Policy actors have different ways of responding to reinforcing and counteracting interdependencies. Most research studying policy issue interdependencies currently does not consider this variability. In our case, actors avoided collaborating over reinforcing interdependencies, which may partly be because reinforcing interdependencies rely on voluntary, collaborative mechanisms that often have a vague jurisdictional status, and include 'risky choices' since gains are often unknown a priori. On the contrary, actors ignored counteracting interdependencies as a basis for collaboration, likely because they rely on the formal process by which counteracting interdependencies are managed. Possibly, this explains why actors do not actively seek nor avoid collaborative partners over counteracting interdependencies on their own, albeit our results could also be interpreted as if there was a mix of low awareness and infeasibility to act on counteracting interdependencies.

We encourage future research to explore actors' risk aversion in collaboration over policy issue interdependencies more closely. Policy issue interdependencies are important leverage points for effective governance, yet if associated with high perceived risk, interdependency could feed inaction. This is a salient example of how policy issue interdependency could potentially impact collaborative mechanisms in ways that are not yet studied in collaborative governance research.

draft. DN, TM and MLM and ÖH critically revised the manuscript and provided substantial intellectual content.

Declarations

Conflict of interest No competing interests.

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