Do national borders really matter?
The influence of border perceptions on cooperation in trans-boundary water quality management

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Abstract

The resource water crosses national and regional borders, making coordination among different stakeholders and jurisdictions a relevant condition for successful trans-boundary water quality management. While cooperation is a well-studied issue in political science when it comes to conflict resolution or the management of so-called common pool resources, less attention is given to the actual causes of cooperation – and even less so to the influence borders might have on cooperation. We address this issue by combining insights from policy and border studies and by asking a) how actors involved in trans-boundary water quality management perceive the impact of borders on cross-border cooperation; and b) whether border perceptions have an impact on cooperation between such actors. Drawing on data from a survey in the cross-border region of Basel in the international catchment area of the river Rhine, we analyze border perceptions of and cooperation patterns among actors who are involved in water quality management of surface water of the river Rhine. Through a descriptive analysis we reveal actors' perception pattern of border effects; via an inferential network analysis applying a statistical model of the family of exponential random graph models (ERGM) we test the influence these border perceptions have on cooperation among our set of actors. Our findings show that the perception of borders does have an impact on the emergence of cooperation, thereby enhancing common theories of cooperation.

Keywords: border effects; border perception; cooperation; water resource management; ERGM

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Introduction

When different actors jointly share or use natural resources, coordination of their actions and the exchange of information about the resources' condition are essential. In the special case of the resource surface water, actions undertaken by up-stream actors can affect the condition of down-stream actors. This brings a unidirectional externality into play that we do not observe with other natural resources. Also, water crosses regional or national borders, making resource use settings trans-boundary. In trans-boundary surface water settings the resource is used and managed by stakeholders from different regions or states, whose actions are based on different jurisdictions. To assure a harmonized and considerate management of the resource water, these actors need to discuss their needs regarding the resource and its services and coordinate their actions. In short, they need to work together, that is cooperate. Such multi-level, cross-sectoral and cross-border coordination is said to enhance effective and efficient policymaking and to guarantee the coherent management of the natural resource at stake (Lubell and Edelenbos 2013; Nesheim et al. 2010).

If we claim that cooperation across borders is important in a trans-boundary surface water setting, we should think of what role such borders play when it comes to cooperation between these actors. Borders are not simply territorial dividing lines and political institutions. They are also social constructions (Paasi 1999). Their roles and signification cannot solely be derived by their forms or formal functions but emanate from the meanings actors attach to them through their practices and representations.

In this paper we focus on the role the *perceptions* of national borders play in the context of trans-boundary water quality management. We analyse how borders are *perceived* by actors engaged in trans-boundary water quality management and whether these perceptions have an effect on actors' cooperation. We thus pose the following two research questions: *How do actors engaged in trans-boundary water quality management perceive the impact of borders on cross-border cooperation? And to what extent do border perceptions impact cooperation among actors engaged in trans-boundary water quality management?*

To answer our research questions, we draw on data from the trans-boundary water quality management setting in the cross-border region of Basel, in the catchment area of the river Rhine. We collected data on collaborative interactions and border perceptions of actors engaged in water quality management in this region through a survey in spring 2016.

Through a descriptive analysis of actors' border perceptions we will answer our first research question. By applying inferential social network analysis running a statistical model of the family of exponential random graph models (ERGM) we test the influence border perceptions have on cooperation in a trans-boundary water quality management setting.

The paper is structured as follows. The first section underlines the theoretical groundings of our study and develops the research hypotheses. The second section presents our research design and introduces the case selection, the method of data gathering, the operationalization of our dependent, independent and control variables and the statistical method applied. In the third section, we present our results. The last section sets out the wider conclusions of our findings.

Theoretical background

While cooperation is a well-studied issue in political science when it comes to conflict resolution or the management of so-called common pool resources, less attention is given to the actual causes of cooperation. Especially the influence of spatial dynamics on cooperation is not well examined. The study of the effects of political-administrative boundaries on policy ties remains a marginal topic of investigation in most social sciences that deal with such issues. We address this research gap by combining insights from policy, common-pool resource (CPR), socio-ecological system and border studies, taking a more explorative approach when formulating our hypotheses.

The definition of cooperation

Cooperation is understood as a "working together" of two or more collective actors that aim at the same goal. The idea behind is that united actors achieve more benefits than on their own. If mutual working is *not* intentional it is considered "interaction". The duration of cooperation can vary depending on the necessity the actors see in it. West et al. (2007) define cooperation as a social behaviour of actors and suppose that it provides actors applying this behaviour with a direct benefit. This benefit is high enough to outweigh the costs of performing cooperation (West, Griffin, and Gardner 2007, 416). Cooperation defined as a *specific type of interaction*, namely intended and well-directed interaction, can be understood as a network because as Jakobi (2009) and Scharpf (1993) argue: "established pattern of interaction between different actors that are interested in a common subject matter" (cf. Jakobi 2009, 4) can be defined as networks (Jakobi 2009; Scharpf, 1993, 72). We conceptualize cooperation thus as a *specific type of actor network*: the network of cooperation existent in trans-boundary water quality management. A network of cooperation is a network of actors interacting with each other intentionally having a common goal in their eyes. The network is conceptualized as graphs where the nodes represent actors (i.e. organizations) and the edges are cooperation ties between these actors.

The concept of borders in CPR theory and theories of cooperation

Common-pool resource (CPR) theory has identified a range of conditions on the resource's as well as at the actors' side "that are supportive of the emergence of cooperation" (Schlager 2004, 151). But none of these conditions considers the effect of territorial borders. On the side of the resource conditions we find "the spatial extent of a resource system" that implies the dimension of space, but which does not relate to the concept of border. Neither is the aspect of borders represented among the actors' conditions that are in favour of cooperation.[2] Other studies focusing on triggers for cooperation came to the conclusion that a sound knowledge of the resource's problem (Heikkila and Gerlak 2005, 605), similar beliefs among actors, and state actors with formal decision-making power who tend to be more active in cooperative settings enhance cooperation (Ingold and Fischer 2014, 95) – factors that do not consider border effects. A leadership position of one or several actors was also identified as a key mechanism of cooperation in a study on trans-boundary water governance in the USA and Canada (Norman and Bakker 2005, 16). In their research Norman and Bakker (2005) conducted interviews with persons "active in water governance" in two cross-border regions at the US-Canadian border. They observed that many of their interviewees pointed out that different governance structures in the two countries were a barrier to cooperation (Norman and Bakker 2005, 16). Despite this study, administrative and political borders remain for the most part a neglected issue in CPR theory and studies on cooperation. CPR theory has not yet scrutinized the significance of borders for cooperation in resource use settings. Whenever the term boundary is used in socio-ecological system analyses, it refers to ecological borders (e.g. resources' boundaries or the crossing of one ecological system into another), the social distinction between actors or the division between the social and the ecological spheres (Bodin et al. 2016; Bodin, Sandström, and Crona 2016).

[2] These are, inter alia, trust and reciprocity among the actors; a certain autonomy towards higher level authorities; and a common understanding of the functioning of the resource's system (Schlager 2004, 152).

The ambivalent effects of borders on social interactions

Theories that explain border effects are not specific to inter-organizational network relations, but common to all sorts of social phenomena. The presence of territorial borders which delineate, separate and differentiate space into distinct territorial units and which determine the territoriality of social actors influence the way in which interactions occur. Defined as territorial dividing lines borders frame social action and interaction (Newman 2006). There is a greater ease of operating within known structures and networks and nation-states are the principal providers of such a familiarity (Helliwell 1998). Conversely, unfamiliarity hinders the creation of community (Spierings and van der Velde 2013) and, by implication, the development of common policy objectives. The existence of institutional, cultural or mental barriers also leads to increasing uncertainty and transactions costs and explains in parts why borders still matter (Houtum 1998). As van Houtum (1999, 330) explains:

> *« Several authors have argued that social interaction and socialization processes, despite or maybe because of the globalization, are still most dominant in the home region and nation (Porter 1990; Paasi 1996; Storper 1997). The social interaction with others in a bounded territory, provides individuals with feelings of familiarity, security and identity. Borders therefore not only separate different territories, but also different nations, systems of socialization, and identities. »*

For all these reasons borders are usually considered to have a *negative* impact on social interactions. They are considered as barriers that impede flows and exchanges. However, understood as social and political constructs borders are not fixed but rather subject to contestation and change. Due to de-territorialisation and re-territorialisation processes, borders can shift in time and space; their meaning and significance can alter as new practices develop. All this complicates the border effect puzzle. In some cases, national borders have been progressively opened to the flows of people, goods, finance and services. Intra-EU borders as one such example owe this to the European Union's internal market and the Schengen Agreement. On the one hand, following van Houtum's (1999) argument aforementioned, we may nevertheless hypothesize that the institutional, cultural and mental barriers that persist are negatively affecting cross-border policy interactions. In addition, the time-dependence of public policies often implies that the gradual opening of borders does not necessarily translate into immediate effects. In other words, national borders having become more porous does not imply that the above-mentioned negative effects have disappeared.

On the other hand, opening borders may offer new opportunities for actors that are engaged in cross-border relations and cooperation and may therefore also be conceived of as having *positive* effects on social and political interactions. According to van Geenhuizen and Ratti (2001) the advantages that flow from a greater opening-up of borders are linked to three factors, namely the presence of opportunities for interaction, the limited impact of any residual barriers, and the capacity of actors to face new challenges. The main reason why the opening of borders may offer new opportunities has to do with the possibility of taking advantage of (a) the contact factor (borders as interface), (b) the differentiation factor (borders as locus of hybridization and innovation), and (c) the affirmation factor of borders (borders as symbols). First, the opening of borders may induce positive externalities due to cross-border spill-overs. In addition, the access to critical mass in terms of knowledge networks or other resources represent key elements for scale and agglomeration economies (Rietveld 2012). Second, as noted by Sohn (2014, 596) "the confrontation of different ideas, values and representations can lead to the overcoming of constraints through negotiation and innovation." The border opportunity is therefore founded on valorising mutual differences (i.e., complementarities) and processes of adaptation as well as mutual learning negotiated through daily contacts (i.e., hybridization and innovation). Third, the symbolic dimension of the border can also be mobilised by actors that engage in cross-border activities and who aim at reinforcing their political or institutional prestige and recognition.

The research questions and hypotheses

Border effects and even more so the effect of border *perceptions* on cooperation are under-represented in theories on cooperation and social-ecological systems as well as in CPR theory. Theories explaining border effects do not consider the aspect of border *perceptions* and their influence on social interaction either. Given that there exist 276 trans-boundary river basins accounting for about 60% of the worldwide freshwater flow[3] *cross-border* water use settings are rather the rule than the exception. If we further consider that more than half of these international river basins "lack any type of cooperative management framework" (De Stefano et al. 2010, 67; UN 2012, 32), it becomes even more evident that research on *the impact of borders on inter-organizational cooperation* is noteworthy. We therefore state the following two research questions:

RQ 1: How do actors engaged in trans-boundary water quality management perceive the impact of borders on cross-border cooperation?

RQ 2: To what extent do border perceptions impact cooperation among actors engaged in trans-boundary water quality management?

To answer our first research question we draw on theoretical insights presented earlier: we defined nine types of border effects on cross-border cooperation that we presented in our survey. The nine border effects are: a) diverging political-administrative systems; b) different idioms; c) diverging personal and financial resources; d) different salience of a topic; e) different priorities regarding the course of action; f) different norms (i.e. limiting values); g) joint learning; h) complementing expertise and capacities; and i) sharing of costs. In our survey, we asked the actors to evaluate their perception of these different border effects on cross-border cooperation. The analysis of their responses will provide answers to our first research question.

To formulate a theoretical answer to our second research question we draw on thoughts from the aforementioned theories stressing the *positive* as well as the *negative* effect borders can have on social and political interactions.[4] We want to make the general point of border effect perceptions playing a role for the emergence of cooperation:

H 1: The more negative actors' perceptions of border effects on cooperation are, the less likely it is that these actors engage in cooperation.

H 2: The more positive actors' perceptions of border effects on cooperation are, the more likely it is that these actors engage in cooperation.

Research Design

The case of the tri-national region of Basel

To answer our research questions we analyse cooperation patterns and border perceptions among actors engaged in water quality management within a trans-boundary region. Our case study is the cross-border region of Basel in the international catchment area of the river Rhine. It

[3] UN Water. Topic: transboundary waters. http://www.unwater.org/topics/transboundary-waters/en/

[4] Our first research question being a descriptive and explorative one does not ask for a hypothesis.

is a single case study, whose object of study – the cooperation within water quality management in a trans-boundary region – "is a specific, unique, bounded system" (Stake 2008, 445). Basel is located at the international tri-point where Switzerland, Germany and France meet. Thus, actors involved in water quality management of surface water of the river Rhine come from different countries, different sectors and act at different levels. The territorial setting that prevails in the tri-national catchment area of the river Rhine in Basel makes this case particularly relevant for our empirical investigations given the unavoidable nature of national borders in water quality management. Our method is that of inferential network analysis, which implies that we do a quantitative analysis within our single case study. Besides the statistical analysis, we also apply an explorative and descriptive approach when answering our first research question. The case study which is "an empirical enquiry that investigates a contemporary phenomenon in depth and within its real-life context" (Yin 2009, 14) is thus suitable for the purpose of our study.

The water quality issue at stake is that of micro-pollutants in surface water in the river Rhine. Micro-pollutants are chemical substances appearing in very low concentration in surface water. They are released to the environment through human activities like production processes in industry, through settlements and agriculture. They are a rather new issue in environmental politics, as they were not detectable in water resources until recently. Studies show that micro-pollutants have negative impacts on ecosystems and scientists concern that they are carcinogenic and may increase physiological changes in animals (Touraud et al. 2011). Micro-pollutants in surface water are a common-pool resource (CPR) problem: by diminishing water quality they constitute a water *quality* issue. In CPR theory this phenomenon is framed as a problem of over-appropriation: the over-exploitation of the CPR water through its infiltration with micro-pollutants creates negative externalities (Villamayor-Tomas et al. 2014, 364). Micro-pollutants can also be interpreted as a supply-side provision problem that refers to the appropriators' motivations to contribute to the maintenance or provision of a CPR (Ostrom, Gardner, and Walker 1994, 9ff). Micro-pollutants are thus a typical and topical example of a common-pool resource and a water quality problem.

The data

We derive our data from a survey carried out in spring 2016. A total of 49 collective actors was identified as being actively involved in the management of micro-pollutants in the surface water of the river Rhine in the Basel region. The actors were identified through expert interviews which were led in March and April 2016 and through an actors' analysis based on the socio-economic system (SES) framework.

In order to gather information on the level of organizations we interviewed managers, CEOs and heads of office who we can safely assume to possess a fair understanding of the actions of their respective organization as well as of the regional water quality policy regarding micro-pollutants and the actors involved in it.

Additionally to the interviews, we identified the actors using the SES framework. The SES framework is an analytical tool to study the influence social and ecological factors have on actors' interactions (Sadoff and Grey 2005, 424). The framework helps reflecting dynamics between the ecological and the social sphere when analysing a certain environmental issue and the interactions of actors involved in this environmental issue. It consists of a so-called "action situation" within which these interactions take place and four components representing the social and the ecological system respectively. These components describe the external factors that influence the action situation. The resource system (RS) and the resource unit (RU) represent the ecological system and are connected as the RU is always a part of the respective RS under scrutiny.

The governance system (GS) and the actors (A) stand for the social system. They are linked with each other as the governance system, understood as the rules-in-use[5], rule-making organizations and the respective policy area (McGinnis and Ostrom 2014), is defining and setting the rules actors behave upon (Basurto et al. 2013, 1367; Ostrom 2009). The SES framework offers a way to identify those actors involved in the environmental issue of micro-pollutants: we checked for all those actors in the region of Basel that are *users* of the *resource unit* surface water (belonging to the *resource system* river Rhine) and its pollutant micro-pollutants. We distinguished between direct and indirect users and evaluated the intensity of the surface water use, the actor's dependence on the resource unit and whether the resource unit's quality was essential for the use. Through this approach we identified a range of environmental NGOs and scientific actors (indirect users), service provider like water works (direct users), and industrial actors like waste water treatment plants and pharmaceutical firms (direct users)[6]. Furthermore, we identified the actors through their relation to the *governance system*. We searched for rule-making organizations in the policy area "water policy" in the Basel region that are in charge of the regulation of micro-pollutants. Also, we scrutinized which actors had commented on the laws and regulations concerning micro-pollutants. This left us with 49 *corporate* actors comprising public and private entities embedded in the trans-boundary water quality management of the Basel region, coming from different sectors like industry, the civil society, water associations, science and the state.
The data was collected through a structured questionnaire that was sent to all 49 actors via post and E-mail. The questionnaire comprised questions about the actors' interaction pattern with each other, their exchange of information and their perception of border effects.[7] Out of the 49 actors targeted 13 actors did not respond, which results in a network comprising 36 organizations. The response rate amounts to 73.5%.

The operationalization of the dependent, the independent and the control variables

The actors were asked about their cooperation activities and their information exchange pattern. Their answers were then transformed into numerical data as required for Social Network Analysis. That is, through a questionnaire we were asking the actors to indicate in a list comprising all actors of the survey those ones the actors' had been and still are cooperating with. We defined cooperation as the discussion of insights; the joint working out of options; the exchange of each other's attitudes towards the issue at stake; and the evaluation of alternatives. We transformed the actors' answers into a network matrix indicating which actors had been cooperating with each other. This conceptualization of a network of cooperation provides the *dependent variable*: cooperation ties between actors in a trans-boundary water quality mangement network.

The survey's question about actors' perceptions of border effects on cooperation was subdivided in nine questions. Each one concerned one type of border effect and its possible impact on cross-border cooperation as perceived by the actors. The actors' answers to these nine sub-questions were then converted into an *index of the actors' perception of border effects on cooperation*. Six of the single border effects were associated as having a *negative* impact on cooperation while the other three border effects were given a *positive* connotation regarding their impact on cooperation.[8] Whenever the actors agreed on a border's effect on cooperation, be it positive or

[5] That is, legal regulations and instruments regarding the environmental issue under investigation.
[6] In the case of industrial actors, use is understood as the use of surface water to dispose of chemical sewage, thereby creating the environmental problem of micro-pollutants.
[7] All these questions were asked to be answered from the organization's point of view (and not from the individual's point of view).
[8] The border effects associated with a *negative* impact on cooperation are: a) diverging political-administrative systems; b) different idioms; c) diverging personal and financial resources; d) different salience of a topic; e) different priorities

negative, this answer was valued with a 1. To build the index, we first calculated each actor's average value of his perception of the *negative* and *positive* border effects respectively, to then subtract each actor's average *negative* border effect perception from his average *positive* border effect perception. This left us with an index ranging from -1, meaning an actor perceives borders as having a very negative effect on cooperation, up to +1, indicating an actor that perceives borders as having a very positive effect on cooperation, with 0 indicating a balanced perception (i.e. the border is perceived as having as much negative effects as positive effects). This index of actors' border perception regarding its effects on cooperation serves as *independent variable*.

As there might be much more factors accounting for the creation of a cooperation tie between two actors in our study's network of cooperation, we want to control for certain variables. To check for the influence similarity effects among actors could have on tie creation, we control for the following homophily covariates: an actor's competence area, i.e. the level the actor is working at; the actor's type; the actor's nationality (being Swiss or not Swiss) and the actor's beliefs[9].

As we had asked the actors in our survey to indicate those actors they deem important in the management process of micro-pollutants, we control for the impact an actor's importance may have on tie creation.[10] Furthermore, we control for two spatial variables that might account for the creation of a tie between actors: the distance between actors – following the argument that the closer two actors are the more likely is the chance that the two create a cooperation tie – and the actor's distance to the border in the Basel region – arguing that being closer to a border may decrease the chance of engaging in tie creation with actors across the border as borders function as a barrier.

Finally, we control for endogenous network effects, variables that are essential to the method we apply.

The method

To test whether the perception of border effects on cooperation has an influence on the creation of a tie between two actors in a network of cooperation, we apply a statistical model of the family of exponential random graph models (ERGM). ERGMs enable one to model the structure of ties of an entire network by depicting it with endogenous structural network properties and covariates. Endogenous network effects are inter alia triangles, cycles, density or clustering while exogenous network effects comprise edge covariates like different relations and node attributes (like actors' age, sex or type) (Leifeld and Schneider 2012, 737; Hunter et al. 2008). The model not only estimates the covariates' effects on network ties while simultaneously controlling for the influence of endogenous network effects on network ties; it also projects parameters which describe the forms of dependence existent in relational data (see Cranmer and Desmarais 2010, 67). The ERGM thus takes network dependencies into consideration when estimating the causes for tie creation in a network. It is run via Markov Chain Monte Carlo Maximum Likelihood Estimation (MCMC MLE) and computed with the `ergm` package for R that comes with the `statnet` suite of packages (Handcock et al. 2003).

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regarding the course of action; f) different norms (i.e. limiting values); the border effects with a positive connotation regarding their impact on cooperation are: g) joint learning; h) complementing expertise and capacities; and i) sharing of costs.

[9] Data on actors' beliefs were also collected through the survey: in the questionnaire we asked actors about their deep core beliefs (cf. Sabatier and Weible 2007; Sabatier and Jenkins-Smith 1999). Based on the actors' answers we grouped them into factions with same beliefs.

[10] Based on these data we coded all actors named important by 9 or more actors as important.

We included the following parameters into the model: The *dependent* variable, i.e. actors' ties in the network of cooperation, processed into a directed network matrix; the *independent* variable, i.e. the index of border effect perception for each actor; and the *control* variables, comprising:

a) *exogenous* factors, that is the following actor covariates:
   - spatial variables: actors' competence area (regional; cantonal; national; Rhine basin wide) & actors' proximity to a border (binary coding: being close to a border defined as being 30 km or less from the border)
   - actor attributes: actors' importance, actor type (state actor; water association and environmental NGO; service provider; industry) & actors' nationality (Swiss or Non-Swiss)
   - edge-covariates: actors' beliefs & distance between the actors

b) the following *endogenous* network effects:
   - k-Outstars and In-stars
   - reciprocity
   - constant in-degree value throughout the randomly generated permutations of the original network (Gwidegree[11])
   - triads (gwesp for closed triads and gwdsp[12] for open triads)

In addition to the ERGM that we calculated for our dependent variable *tie creation in the network of cooperation*, we ran ERGMs for two other network relations among the actors. Having also asked the actors about their technical and political *information exchange* among each other, we checked for the independent and control variables' influence on these two other network relations in the same group of actors as well. We did so to check up on the data's as well as the ERGM's reliability (for results on these two ERGMs see Appendix I, models 2 and 3). Furthermore, we ran ERGMs estimating the single influence of *each of the nine border effect perceptions* on the creation of a cooperation tie. As these models didn't give any sound results we focused on the *border effect perception index* as sole independent variable.

Analysis & Assessment

In the following, we are discussing the results of our analysis. Starting with the features of the network of cooperation and our dependent variable, the actors' ties within this network, we then describe the variation of border effect perceptions among the actors. Finally, we outline the results of our inferential network analysis and infer the influence perceptions of borders might have on cooperation.

Features of the network of cooperation

The network of cooperation consists of 36 nodes – the actors engaged in water quality management of micro-pollutants in the Basel region – and has a density of 20.2 %, which reflects the fraction of all possible connections among nodes that is actually realized. The cooperation network is rather dense. Looking at the network as a graph (figure 1) we can see that actors that have been deemed important by the other actors – appearing in the graph as bigger circles and squares respectively – also have a central position within the network. The centrality measure we applied is degree centrality that is the in-coming and out-going ties an actor has. We can also see

[11] Gwidegree being the abbreviation for "geometrically weighted in-degree distribution".
[12] Gwesp standing for "geometrically weighted edgewise shared partner distribution", gwdsp meaning "geometrically weighted dyad-wise shared partner distribution".

that the German actors (GER 1, GER 2 and GER 3)[13] are closely grouped together on one side of the network while French actors (FR 1 and FR 2)[14] are linked to each other and to the international actors[15].

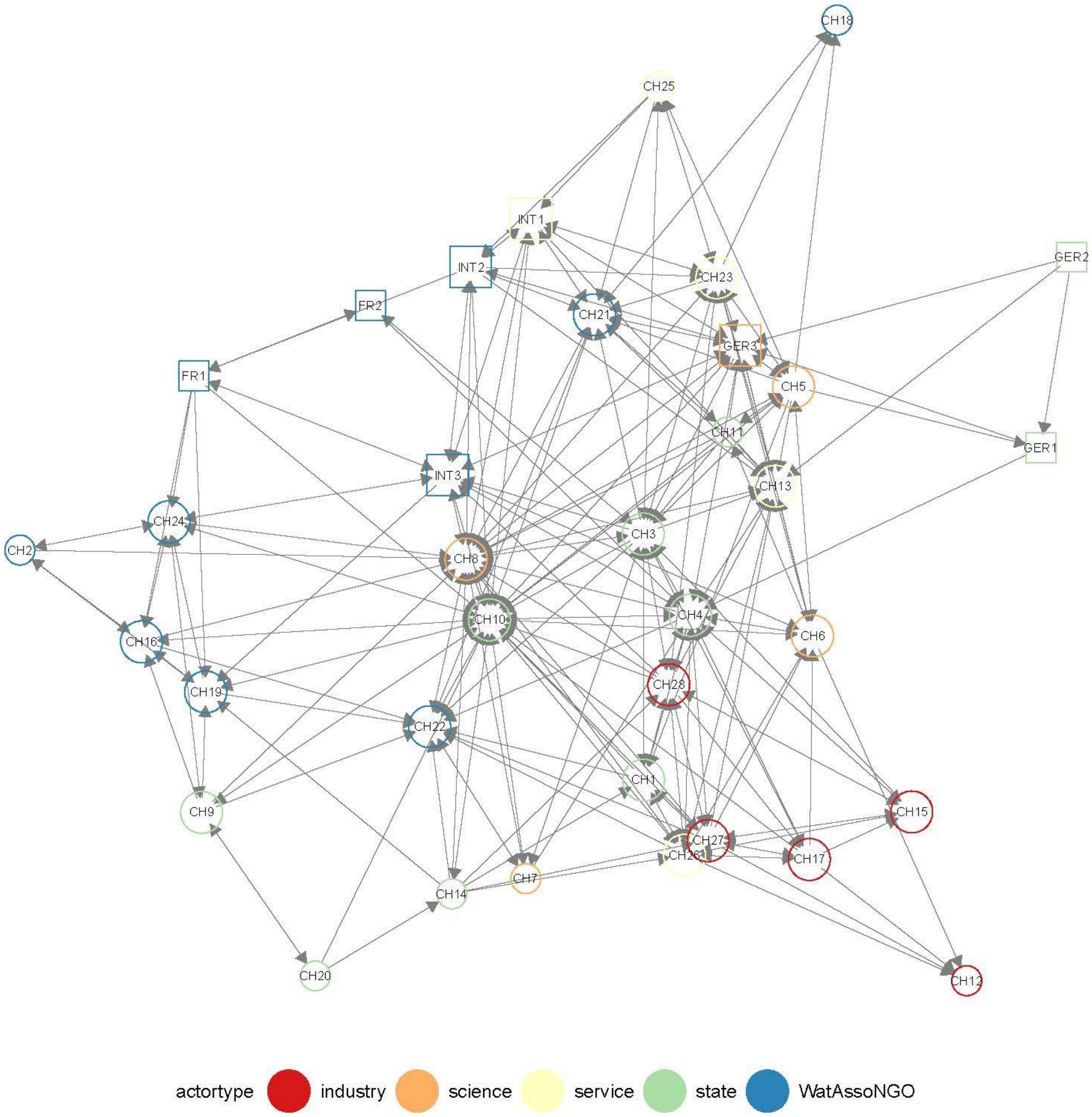


Figure 1: the network of cooperation, depicted with degree centrality. Circle nodes indicate Swiss actors, square nodes are Non-Swiss actors; the colours show the nodes' actor type.

If we further look at the actors' types we observe that most actor types group together: industrial actors (red nodes) cluster together as well as water associations and environmental NGOs (blue nodes). Central actors from science (CH 5, CH 6, CH 8 and GER 3) and the state (CH 3, CH 10 and CH 14)[16] seem to function as links between industrial actors, service provider and water associations and environmental NGOs.

[13] The three German actors are two state actors at the regional level and one scientific actor located in Karlsruhe, Germany. For an entire list of the actors see Appendix II.
[14] The two French actors are two environmental NGOs active in water protection.
[15] The international actors in the network are: the Association of Waterworks Lake Constance-Rhine (AWBR), the International Association of Water Works in the Rhine Basin (IAWR), and the International Commission for the Protection of the Rhine (ICPR).
[16] Those scientific actors are the Cantonal Laboratory of the Canton of Basel City (CH 5), the Cantonal Laboratory of the Canton Basel Landschaft (CH 6), the Swiss Federal Institute of Aquatic Science and Technology (Eawag) (CH 8) and the

Looking at the actors' nationalities – circle nodes are Swiss actors, square nodes are not Swiss –, it becomes clear that the cooperation network of actors involved in water quality management in the region of Basel with the specific focus on micro-pollutants is limited to a wide range of Swiss actors and only a few international, German and French organizations. This fact, that first became apparent when identifying the relevant actors, is already a finding itself: it shows that cross-border cooperation in water quality management in the region of Basel does not involve many actors across the Swiss-French and the Swiss-German border, but is mainly handled by Swiss actors. All the more is it interesting to understand how these actors perceive this border in regard to their work and whether this perception has an influence on the actors' involvement in cooperation, that is, their creation of ties with other actors.

Pattern of border effect perceptions

When looking at the actors' answering pattern concerning their perception of the nine individual border effects on cooperation (see figure 2), two aspects stand out: first, state actors and water associations together with environmental NGOs tend to perceive all nine border effects as influencing cooperation. Scientific actors, the industry and service provider perceive the different border effects as differently influential on cooperation. For instance, none of the industrial actors perceives *different idioms* as a hindrance to cooperation while 80 % of the industrial actors see a *different salience of the issue* (in our case micro-pollutants in surface water of the river Rhine) by actors coming from different sides of a border as a barrier to cooperation.

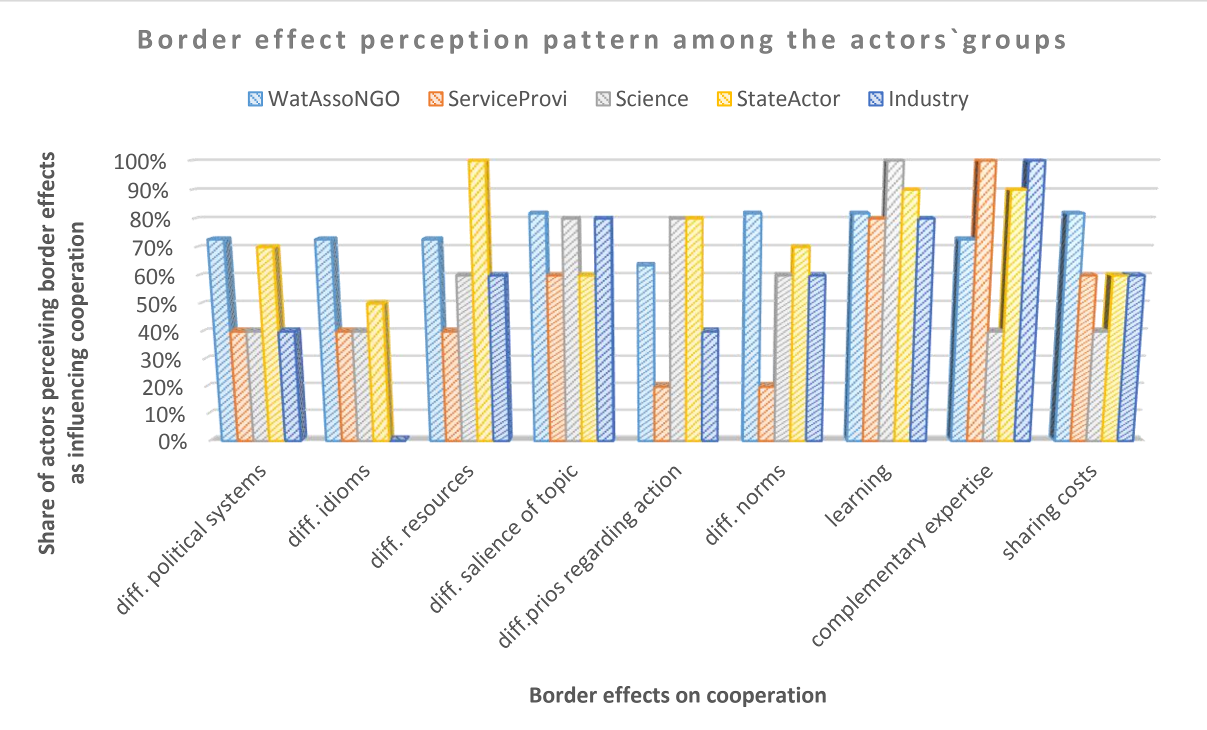


Figure 2: border effect perception pattern among actors` groups.

Second, three border effects have a strong variation on how they are perceived by the actor groups: *different priorities regarding the course of action* to be taken (in order to solve the issue at stake), the *different political systems* on each side of the border and, a little less so, the *sharing of*

Technologiezentrum Wasser, Karlsruhe (TZW) (GER 3); the central state actors are the Cantonal Office for Environmental Protection and Energy, Basel Landschaft (AUE BL) (CH 3), the Federal Office for the Environment, Switzerland (FOEN) (CH 10) and the organization of municipal infrastructure Switzerland (OKI) (CH 14).

costs across borders. Especially service provider and industrial actors do not perceive the different prioritization about the actions to be taken as a strong hindrance to cooperation; those two actor groups together with scientific actors also perceive different political-administrative systems less cumbersome than state actors and environmental NGOs together with water associations do. Sharing costs is also not such an important factor for scientific actors than it is for environmental NGOs and water associations when it comes to cooperation.

The variation in the answering pattern among the actors' groups can mainly be explained by the nature and stakes of each actor group. While service provider "simply" follow national guidelines and limiting values, state actors, NGOs with water associations and industrial actors bargain about exactly these guidelines and limiting values – which may lead to a different perception of these border effects on cooperation. Similarly do *different resources* and *different political-administrative systems* play a bigger role for state actors and water associations and NGOs, who are dependent on public financing and the state system for their work, than they do for private or semi-private entities who have a fixed budget and act outside political systems.

Looking at the aggregated perception of borders' effects on cooperation, that is the index (figure 3), we can see that most of the actors have an index value ranging between -0.25 and +0.24 (that is 17 actors or 47.2%). This indicates that these actors perceive borders as neither having a negative nor a positive influence on cooperation. Looking more closely at whom these actors are we find that the two German state actors, one French NGO and Swiss actors from all five actors' groups[17] are represented. Actors perceiving borders as having mainly a negative effect on cooperation are exclusively Swiss actors from the group of water associations and environmental NGOs (all three having an index of -0.67), the state (indices of -0.5 and -0.17) and science (indices of -0.33 and -0.17). Actors perceiving border effects on cooperation as mainly positive come from all five actors' groups, with water associations and environmental NGOs and the industry being in the majority.

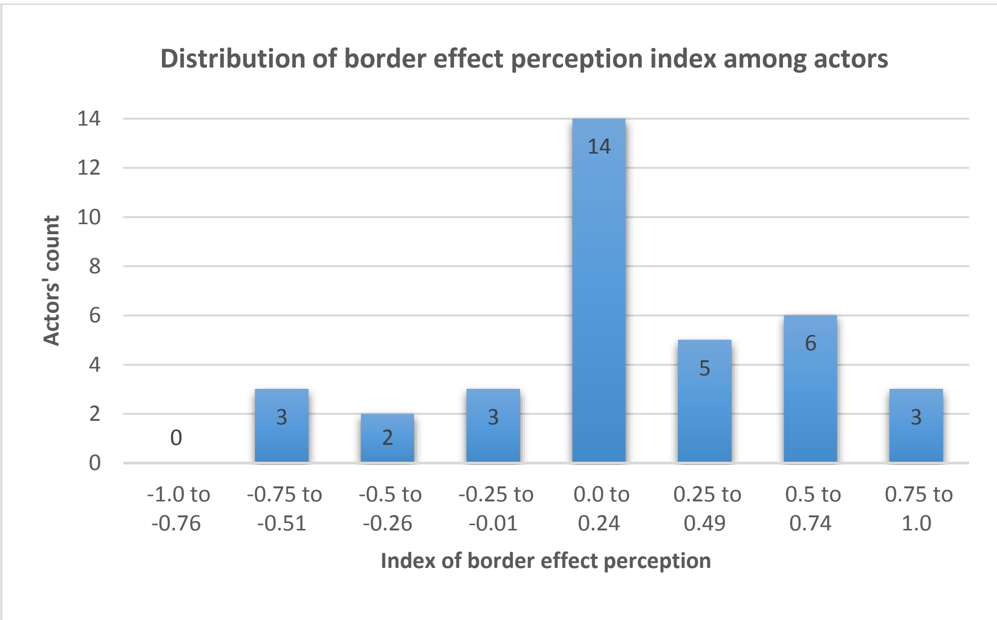


Figure 3: distribution of the border effect perception index among actors.

[17] The five actors' groups are: service provider, state actors, industrial actors, science, and water associations with environmental NGOs.

Influence of border effect perception on cooperation

In the following, we outline the results gained from testing the influence these border effect perceptions have on the creation of a tie between two actors in the network of cooperation.
We did an inferential network analysis running an exponential random graph model (ERGM) to test the hypotheses. We checked for the independent and control variables' influence on each of the actors' *incoming* as well as *outgoing* ties in the network of cooperation.

As mentioned in the section about the method, we also ran ERGMs for two further network relations among the actors: their *political information exchange* relations and their *technical information exchange* relations. There were no interesting findings on border effect perceptions' influence on the tie creation in the former (see also Appendix I, model 2). The ERGM for the border effect perceptions' impact on tie creation in the latter (see Appendix I, model 3) showed similar results as the model we estimated for the *cooperation network* (model 1). Overall, the values of the parameters showed a similar and coherent pattern across all three models, indicating that results are robust.

The results of the ERGM for the cooperation network are displayed in table 1.[18] The ERGM's parameters (model 1) show a significant positive correlation between our independent variable "index of border effect perception" and the creation of *in-coming* cooperation ties of actors in the network. This indicates that a positive index, i.e. the fact that the border is perceived more as opportunity than as a constraint, increases the likelihood of an actor having in-coming ties. Concerning an actors' *out-going* cooperation ties, the result does not show a significant correlation with the index of border effect perception. Nevertheless the results partially corroborate our second hypothesis which states that the higher the positive perception of border effects on cooperation, the likelier it is that actors engage in cooperation.

In order to check whether *negative* values of the border perception index play a role in the creation of ties, in other words, to see whether a negative border perception impacts the creation of a tie between two actors, we adjusted our independent variable, i.e. the index. We split the index into two separate independent variables, one indicating the *negative effects* an actor is attributing to borders (IV B: an actor having a negative value of the border perception index), the other standing for an actor's *positive* perception for borders' *effects* on cooperation (IV C: an actor having a positive value of the border perception index).
The variables were coded binary[19] and an ERGM was estimated for each independent variable's impact on the creation of a tie in the network of cooperation (model 1B for the IV B and model 1C for the IV C). The statistical estimations (model 1B) show a significant negative correlation between the independent variable B "negative index value" and an actor's in-coming ties in the network of cooperation. An actor who perceives border effects as negative – independent of the perception's intensity – is thus less likely to have in-coming ties. Or put differently, if an actor perceives border effects as a hindrance to cooperation, then he is likely to receive less in-coming ties. This finding supports our first hypothesis "the more negative actors' perceptions of border effects on cooperation are, the less likely it is that these actors engage in cooperation" only partially: it tells us that the solely negative perception of border effects influences tie creation; it cannot give any information on the negative border perception's *intensity* and its impact on the

[18] We restricted the list to those factors that have a significant correlation with the creation of a tie between two actors.
[19] For the independent variable B – actor having a negative border perception index – actors with an index value of 0 or greater than 0 were encoded as a 0 while actors with an index value less than 0 were encoded as a 1. For the independent variable C – actor having a positive border perception index – it was the other way around: actors with an index value of 0 or less than 0 were encoded as a 0 while actors with an index value greater than 0 were encoded as a 1.

creation of a tie. The ERGM for our independent variable C “positive index value” (model 1C) indicates that whenever an actor has a positive perception of border effects on cooperation, s/he also has an increase in in-coming ties, as there is a strong positive correlation between IV C and an actor’s in-coming ties. This finding supports the results of model 1.

	Model 1[20]	Model 1B	Model 1C
edges	-6.70 ***	-7.50 ***	-8.05 ***
	(1.20)	(0.91)	(1.01)
mutual	1.61 ***	1.60 ***	1.71 ***
	(0.30)	(0.30)	(0.31)
incoming ties: ***border perception index***	**0.94 ****		
	(0.29)		
outgoing ties: *border perception index*	-0.42		
	(0.24)		
incoming ties: ***negative index value*** *(IV B)*		**-0.91 ****	
		(0.30)	
outgoing ties: *negative index value (IV B)*		0.37	
		(0.23)	
incoming ties: ***positive index value*** *(IV C)*			**1.22 *****
			(0.24)
outgoing ties: ***positive index value*** *(IV C)*			**-0.51 ****
			(0.20)
node match: competence area (cantonal)	0.52 ***	0.62 ***	0.61 ***
	(0.13)	(0.12)	(0.12)
outgoing ties: competence area (national)	-0.58 *	-0.55 *	-0.36
	(0.27)	(0.27)	(0.29)
outgoing ties: close to border	-0.44	-0.33	-0.25
	(0.23)	(0.22)	(0.24)
incoming ties: close to border	-0.34	-0.50	-0.83 *
	(0.39)	(0.40)	(0.41)
incoming ties: deemed important	2.45 ***	2.43 ***	2.67 ***
	(0.66)	(0.62)	(0.72)
node match: actor type (industry)	0.75 ***	0.79 ***	0.77 ***
	(0.14)	(0.14)	(0.15)
incoming ties: actor type science	0.89 *	1.19 **	0.82
	(0.41)	(0.46)	(0.43)
incoming ties: actor type service provider	0.86 *	0.87 *	0.71
	(0.38)	(0.39)	(0.39)
node match: being Swiss	0.67 ***	0.71 ***	0.71 ***
	(0.17)	(0.15)	(0.15)
outgoing ties: being Swiss	-0.57 *	-0.54 *	-0.56 *
	(0.25)	(0.25)	(0.25)
incoming ties: being Swiss	0.47	0.53	0.71
	(0.41)	(0.39)	(0.40)
edge-covariate: sharing same beliefs	0.13 **	0.13 **	0.15 **
	(0.05)	(0.05)	(0.05)
edge-covariate: distance between actors	-0.09	-0.00	0.00
	(0.05)		
gwidegree	5.56 ***	5.52 ***	6.38 ***
	(1.60)	(1.50)	(1.71)
gwesp.fixed.1	0.84 ***	0.85 ***	0.85 ***
	(0.10)	(0.10)	(0.10)
gwdsp.fixed.1	-0.02	-0.02	-0.03
	(0.03)	(0.03)	(0.03)
AIC	884.16	886.03	867.41
BIC	1043.46	1045.33	1026.72
Log Likelihood	-411.08	-412.01	-402.71

*** p < 0.001, ** p < 0.01, * p < 0.05

Table 1: results of the exponential random graph model estimations.

[20] The model’s goodness of fit (GOF) proved to be satisfactory.

At the same time we observe a significant negative correlation between IV C and an actor's out-going ties, meaning that an actor has less out-going ties when s/he perceives borders as an advantage to cooperation.

For the *control variables*, the assumption of similarity effects between actors enhancing the chance for tie creation holds true (Berardo and Scholz 2010). So-called homophily between actors, that is similarities between ego and alter, leading actors to engage with their similar counterparts is evident in our data: actors with the same competence area – that is the same level they are operating at –, actors that have the same actor type, and those actors who are Swiss have the tendency to create ties with each other[21]. Actors sharing the same beliefs[22] also tend to share a tie with each other. Actors that had been evaluated as important by the other actors are more likely to receive in-coming ties. A finding that sounds logical: the more important an actor is perceived as, the more in-coming cooperation ties he receives – because the other actors want to be in contact with actors important for the issue at stake. The spatial variables we were controlling for – an *actors' proximity* to the border and the distances *between* the actors – did not prove to be significant in explaining the creation of cooperation ties in our network. A finding that is confirmed by the theoretical interpretation of borders acting as a barrier (van Houtum 1999).
The endogenous network effects on the contrary – thus the factors immanent in the network – proved to be all significant except for the gwdsp term [23]. The gwesp statistic is highly significant and positive, meaning that connected actors are "more likely than pure chance to have multiple transitive shared partners" (cf. Leifeld and Schneider 2012, 739). This refers to the argument that connected actors trust each other in their choice of partners, therefore creating ties with their partner's partners. Furthermore, the gwidegree statistic and the reciprocity statistic ("mutual") are positively correlated to tie creation, while the k-Outstars and In-stars term ("edges") is significantly negative correlated to the creation of a tie between two actors.

We effectively controlled for the common endogenous structural network properties and common similarity effects in the network while furthermore checking for the influence distances between actors and distance towards the common border have on tie creation. Despite the impact of homophily factors and endogenous network effects on tie creation, our results show that the *perception* actors have about the effect of borders on cooperation does have an influence on actors' in-coming ties: the more positive an actor perceives the effect of borders on cooperation, the more in-coming ties s/he receives; and if an actor perceives borders as having a negative effect on cooperation, then s/he is likely to receive less in-coming ties.

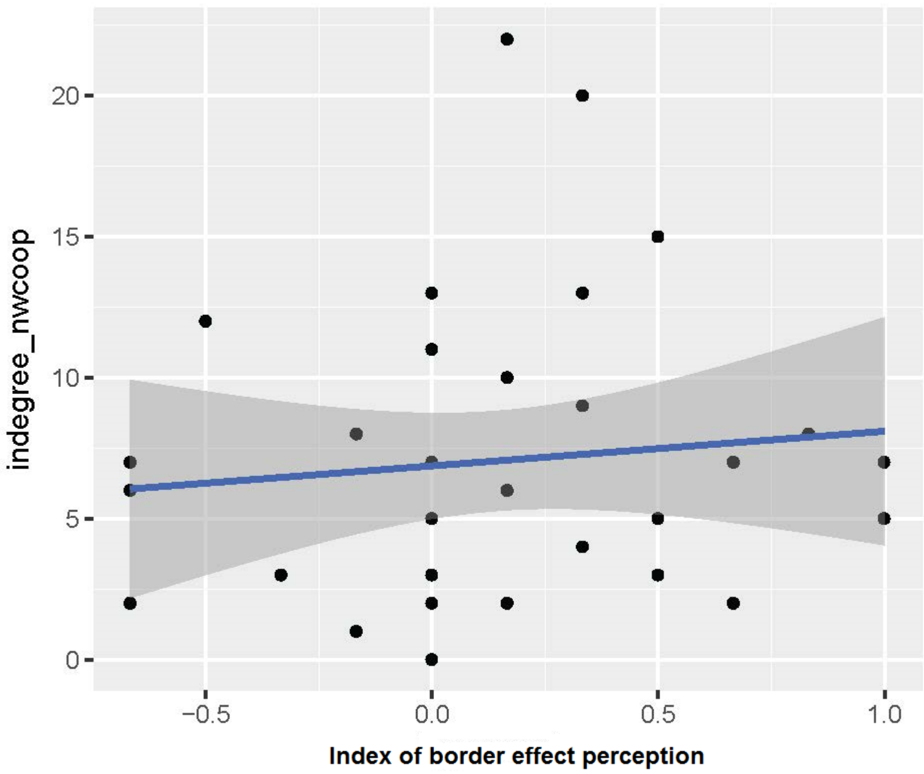
Conclusion

Regarding our analysis of actors' perception pattern of border effects we can state the following answer to our first research question "*how do actors engaged in trans-boundary water quality management perceive the impact of borders on cross-border cooperation*": about 47% of the actors perceive borders as having positive as well as negative effects on cooperation (17 out of 36, see figure 3); about 39% of actors perceive borders as having a rather positive effect on cooperation (14 out of 36). This shows a tendency towards a positive perception of borders and their impact on cooperation among actors engaged in trans-boundary water quality management, focusing on

[21] See "node match" parameters for the respective control variable in table 1.
[22] See "edge covariate: sharing same beliefs" in table 1.
[23] gwdsp "captures the propensity of any dyad (whether connected or unconnected) to have multiple transitive shared partners, which is a baseline effect of shared partners in the network" (Leifeld and Schneider 2012, 739). In other words, the term reflects the likelihood of any two actors, be they connected or not, to have several connections to the same actors, thus "sharing" these other actors; a pattern that is not observed in our network.

micro-pollutants in surface water of the river Rhine in the region of Basel. Looking at the single border effects out of which we built our index of border effect perception, we can see that most actors perceive the border effects “joint learning” and “complementing expertise and capacities” as positively and the border effect “different salience of a topic” as negatively influencing cooperation (cf. figure 2). A bigger variation in actors’ perceptions of border effects can be observed at the single effects “different priorities regarding the course of action”, “different norms” and “different idioms” as well as across the different groups of actors. Environmental NGOs, water associations and state actors all tend to perceive the single border effects as influential on cooperation. Service providers, scientific and industrial actors have a more differentiated perception about the different border effects and their impact on cooperation.

Testing the influence actors’ perceptions of border effects on cooperation have on the creation of ties in a network of cooperation showed that actors who have a more positive perception of borders’ effects on cooperation have the tendency to have more in-coming ties while actors with a simple negative perception of borders’ effects have the tendency to have less in-coming ties. Looking at the distribution of the border effect perception index within our network of cooperation, we can observe that the three actors with the lowest index value of -0.67 (actors CH 2, CH 19 and CH 24) have a rather low degree of in-coming ties sitting at the periphery of the network (cf. figure 1). The eight most central actors of the network with in-degrees of between 11 and 22 (and a reputational in-degree of between 17 and 29)[24] have a rather positive index value of between 0.0 and 0.5[25]. The two observations are illustrating our statistical results. The following graph (graph 1) indicates a very weak relation of an increase of a positive border effect perception and an increase in in-coming ties in the network of cooperation:



Graph 1: relation between actors’ border effect perception index and actors’ in-degree of cooperation ties.

[24] These actors are CH 3, CH 4, CH 8, CH 10, CH 13, CH 21, CH 22 and GER 3.
[25] Two actors having an index of the value 0.0, one having an index of 0.167, three actors having an index of 0.33 and one having an index of 0.5. Only one actor of this group of central actors (CH 3) has a negative index value (-0.5).

Two outliers with a very high in-degree centrality are conspicuous. They are the Swiss Federal Institute of Aquatic Science and Technology (Eawag) with a tie in-degree of 20 and the Water Division of the Swiss Federal Office for the Environment (FOEN) with an in-degree of 22.

Our second research question *"to what extent do border perceptions impact cooperation among actors engaged in trans-boundary water quality management?"* can be answered as follows: first, border perceptions have an impact on cooperation ties of actors engaged in trans-boundary water quality management; and second, they do so in two complementary ways: If an actor perceives a border as having negative effects on cooperation, then s/he is likely to have less in-coming cooperation ties – confirming our first hypothesis only partially. And, the more positive actors' perceptions of border effects are, the more likely is an increase in actors' in-coming cooperation ties – confirming our second hypothesis.

In conclusion, one can claim that the positive as well as the negative *perception* of borders' effects on cooperation have an influence on the creation of cooperation ties between actors in a trans-boundary water quality management setting. We cannot deduce from our study whether positive perceptions are due to already existing cooperation structures, thus whether the positive perception of borders' effects on cooperation is enforced through positive experience of cooperation, suggesting a reinforcing mechanism of cooperation and the perception of borders' effects on cooperation. Also, in a next step our analysis should be widened and applied to other trans-boundary water management settings to check whether results are reliable across cases. Nevertheless, we can state that border perceptions do influence the creation of cooperation ties in water policy management to a certain extent, thereby enriching theories of cooperation.

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Appendix

Appendix I: results of the three ERGMs

	Model 1	Model 2	Model 3
edges	-6.70 ***	-7.72 ***	-6.44 ***
	(1.20)	(1.26)	(1.09)
mutual	1.61 ***	1.75 ***	1.74 ***
	(0.30)	(0.38)	(0.29)
incoming ties: *border perception index*	**0.94 ****	-0.02	**0.86 ****
	(0.29)	(0.36)	(0.28)
outgoing ties: *border perception index*	-0.42	-0.00	-0.03
	(0.24)	(0.29)	(0.24)
node match: competence area (cantonal)	0.52 ***	0.79 ***	0.40 **
	(0.13)	(0.19)	(0.15)
outgoing ties: competence area (national)	-0.58 *	-0.72	-0.78 **
	(0.27)	(0.47)	(0.28)
outgoing ties: close to border	-0.44	-0.52	-0.07
	(0.23)	(0.41)	(0.25)
incoming ties: close to border	-0.34	-0.36	-0.35
	(0.39)	(0.49)	(0.35)
incoming ties: deemed important	2.45 ***	1.76 ***	1.46 ***
	(0.66)	(0.44)	(0.36)
node match: actor type (industry)	0.75 ***	0.83 ***	0.61 ***
	(0.14)	(0.18)	(0.16)
incoming ties: actor type science	0.89 *	0.18	0.91 *
	(0.41)	(0.66)	(0.38)
incoming ties: actor type service provider	0.86 *	0.86	0.70 *
	(0.38)	(0.54)	(0.34)
node match: being Swiss	0.67 ***	0.89 ***	0.80 ***
	(0.17)	(0.23)	(0.17)
outgoing ties: being Swiss	-0.57 *	-0.08	-0.41
	(0.25)	(0.44)	(0.29)
incoming ties: being Swiss	0.47	-0.03	0.57
	(0.41)	(0.58)	(0.39)
edge-covariate: sharing same beliefs	0.13 **	0.11	0.15 **
	(0.05)	(0.06)	(0.05)
edge-covariate: distance between actors	-0.09	0.01	0.00
	(0.05)	(0.07)	(0.06)
gwidegree	5.56 ***	3.37 ***	2.67 **
	(1.60)	(0.95)	(0.95)
gwesp.fixed.1	0.84 ***	0.81 ***	0.66 ***
	(0.10)	(0.10)	(0.10)
gwdsp.fixed.1	-0.02	0.03	-0.07 *
	(0.03)	(0.03)	(0.03)
AIC	884.16	633.90	927.18
BIC	1043.46	793.20	1086.48
Log Likelihood	-411.08	-285.95	-432.59

*** p < 0.001, ** p < 0.01, * p < 0.05

Table I: results of the exponential random graph model estimations for three different network relations: cooperation ties (model 1); political information exchange ties (model 2); and technical information exchange ties (model 3).

Appendix II: List of actors

N°	Actor ID	Original Name	English Name	Index	Incoming ties
1	GER1	Landratsamt Lörrach, Deutschland	District administration of the city of Lörrach, Germany	0,167	2
2	CH1	Amt für Industrielle Betriebe, Basel Landschaft	Department for industrial business, canton of Basel Landschaft	0,67	7
3	FR1	Alsace Nature, France	Alsace Nature, France	0	2
4	FR2	Association pour la Protection de la Nappe Phréatique de la Plaine d'Alsace, France	Association for the protection of the groundwater of the plain of Alsace, France	0,67	2
5	CH2	Gewässerschutz Nordwestschweiz	Prevention of Water Pollution Northwest Switzerland	-0,67	2
6	CH3	Amt für Umweltschutz und Energie, Basel Landschaft	Cantonal Office for Environmental Protection and Energy, Basel Landschaft	-0,5	12
7	CH4	Amt für Umwelt und Energie, Basel Stadt	Cantonal Office for the Environment and Energy, Basel City	0	13
8	INT1	Arbeitsgemeinschaft Wasserwerke Bodensee-Rhein (AWBR)	Association of Waterworks Lake Constance-Rhine	1	7
9	CH5	Kantonales Labor Basel-Landschaft	Cantonal Laboratory Basel Landschaft	-0,167	8
10	CH6	Kantonales Labor Basel Stadt	Cantonal Laboratory Basel City	-0,167	8
11	CH7	Vereinigung der kantonalen Fachleute für Gewässerbiologie und –chemie (Cercl`Eau)	Association of the cantonal experts of water biology and chemistry	-0,33	3
12	GER2	Stadt Weil am Rhein, Deutschland	City of Weil am Rhein, Germany	0	0
13	CH8	Eidgenössische Anstalt für Wasserver-sorgung, Abwasserreinigung und Gewässerschutz (Eawag)	Swiss Federal Institute of Aquatic Science and Technology	0,33	20
14	CH9	Kommissionen für Umwelt, Raum-planung und Energie des Ständerates	Council of State's Committee on the Environment, Spatial Planning and Energy	0	3
15	CH10	Bundesamt für Umwelt (BAFU), Abteilung Wasser	Federal Office for the Environment (FOEN), Water Division	0,167	22
16	CH11	Bundesamt für Lebensmittelsicherheit und Veterinärwesen (BLV)	Federal Food Safety and Veterinary Office (FSVO)	0,5	3
17	CH12	Handelskammer beider Basel (HKBB)	Basel Chamber of Commerce	0,33	4
18	INT2	Internationale Arbeitsgemeinschaft der Wasserwerke im Rheineinzugsgebiet (IAWR)	International Association of Water Works in the Rhine Basin (IAWR)	1	5
19	INT3	Internationale Kommission zum Schutz des Rheins (IKSR)	International Commission for the Protection of the Rhine (ICPR)	0,33	9
20	CH13	Industrielle Werke Basel	Industrial Works Basel, drinking water provider	0,5	15
21	CH14	Organisation Kommunale Infrastruktur	Organization of municipal infrastructure	0	2
22	CH15	Novartis International	Novartis International	0,5	5
23	CH16	Pro Natura, Schweiz	Pronatura: Environmental Protection Organization of Switzerland	0,167	6
24	CH17	F. Hoffmann-La Roche AG	La Roche plc	0	5
25	CH18	Schweizerischer Brunnenmeister-verband	Swiss Association of well gaffers	0	3
26	CH19	Schweizerischer Fischereiverband	Swiss Fishery Association	-0,67	6

27	CH20	Schweizerischer Gemeindeverband	Swiss Association of the Municipalities	-0,167	1
28	CH21	Schweizerischer Verein des Gas- und Wasserfaches	Swiss Gas and Water Industry Association	0	11
29	GER3	Technologiezentrum Wasser, Karlsruhe, Deutschland	German Water Centre, Karlsruhe, Germany	0,33	13
30	CH22	Verband Schweizer Abwasser- und Gewässerschutzfachleute	Swiss Water Association	0,33	13
31	CH23	Hardwasser AG, Basel	Hardwasser plc, drinking water provider in Basel	0,167	10
32	CH24	WWF, Schweiz	World Wide Fund for Nature, Switzerland	-0,67	7
33	CH25	Wasserwerk Reinach und Umgebung	Drinking water provider in Reinach	0,5	3
34	CH26	Abwasserreinigungsanlage Basel, ProRheno AG	waste water treatment plant (WWTP) Basel, ProRheno plc	0	7
35	CH27	Industriekläranlage ProRheno AG	WWTP Chemistry ProRheno plc	0	7
36	CH28	Abwasserreinigungsanlage Rhein, Schweizerhalle	WWTP Rhein, Schweizerhalle	0,83	8