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Organising cross-sectoral collaboration in river basin management: case studies from the Rhine and the Zhujiang (Pearl River) basins

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Introduction

Integrated river basin management (IRBM) involves "management of surface and sub-surface water resources of the river basin in its entirety with due attention to water quality, quantity and environmental integrity" (Jaspers 2003, p.79). IRBM is also associated with participatory approaches that aim to reconcile diverse stakeholder interests in the social, economic and environmental attributes of the basin. It therefore inevitably engages several overlapping institutions and organizations, whose interplay and collaboration within a system of governance transgresses scales and sectors (Sabatier et al. 2005, Young et al. 2008). Various aspects of basin management, such as controlling point and non-point pollution or maintaining environmental flows, illustrate the need for such collaborative interplay.

The purpose of this paper is to analyse the characteristics of the collaboration among organizations involved in RBM in different sectors of administration and economic activity, and the mechanisms put in place to encourage this collaboration. Collaboration is defined in this paper as a process of engaging stakeholders in all stages of the policy process (Koontz 2006), from problem definition to the analysis of viable solutions, decision-making, implementation, monitoring and evaluation. Stakeholders in this context include government officials, representatives of non-government organisations (both business and non-profit sector) and individual citizens. Research on collaborative watershed and environmental management (Leach and Pelkey 2001, Koontz et al. 2004, Koontz and Thomas 2006) has identified key factors affecting success in collaborative initiatives, mostly in the North American context at a time when citizen-led collaborative environmental management and the role of government in this was under review. Those factors include the scope of collaboration (the range of participants and the spatial extent of their interest); the available human, technical and financial resources; interpersonal assets such as trust; the existence of clear rules governing collaboration processes; and the sharing of data and information. Koontz and colleagues (2004) have incorporated these factors into a 'Framework for

Analyzing Governmental Impact' (Figure 1), which we adapted for the purposes of our analysis. This adaption consists of including private, non-governmental actors as well as informal institutions or socially embedded practices in the chain of factors that play a significant role in the emergence of effective collaborative processes.

Figure 1: Proposed Collaboration Impact Framework (based on Koontz et al. 2004)

This paper analyses the drivers and constraints for effective cross-sectoral collaboration in river basin management, and the extent to which the factors identified by Koontz et al. 2004 contribute to success or failure of collaboration in selected case studies. In the first section, we present a brief overview of research methods, information sources, and selected sub-basins. This is followed by a discussion of findings for each case study, describing institutional contexts and collaboration practices while revealing perceived outcomes and their drivers. A comparative analysis of the cases is presented on the basis of the Collaboration Impact Framework. The final section puts forward conclusions and recommendations for further research.

Research methods and information sources

Research design followed a comparative case study methodology using cases where collaboration across sectors at the biophysical scale was fundamental in order to address problems of water pollution. Cases were selected from industrialised and densely populated catchments, where trade-offs among human activities across space are particularly intense. Sub-basins were considered useful units of analysis as they allow for easier identification and access to actors in comparison with entire river basin systems.

Case studies were selected from European and Chinese river basin systems, inspired by the efforts of mutual learning pursued by water managers under the EU-China River Basin Management Programme (RBMP) (2007-2012). From the Chinese side, a specific interest in the history of collaborative development and cleaning up of the Rhine and the Danube river basin systems was expressed by the Ministry of Water Resources in the context of the EU-China RBMP (Silveira 2011). Among these European case study options, the authors chose to select a case study in the basin with the longer history of pollution management at the hydrological scale – the Rhine. On the Chinese side, a case study within the Pearl River basin was selected, on account of the fact that this was the first Chinese basin to witness economic reform since 1978, and to deal with the water management challenges associated with mass industrialization, rapid urbanization, water pollution and hydropower development.

On this basis, this article focuses on three cases: a sub-basin in the Dutch section of the Rhine; a sub-basin in the German section of the Rhine; and a sub-basin in China's Zhujiang (Pearl River) basin. This case study selection enabled a comparative analysis on two levels: (a) between the Chinese and the European sub-basins in order to better understand collaborative forms of management in two very different river basin governance regimes; (b) between the two European cases in the Rhine in order to assess how variable collaborative arrangements can be within a basin governance system.

Given the variety of physical, human and political geographies, more differences than similarities have been expected. The selected sub-basins encompass, for example, geographic areas of very different size (813 km2, 12,000 km2, and 353,100 km2). This may mean a great number of actors involved, depending on the problem at stake (e.g. the number of hydropower operators may still be very small) and the inclusiveness of decision processes adopted. The existence of fundamental differences was considered an opportunity to identify factors that seem to have a significant impact on collaboration practices in even highly heterogeneous social-ecological systems. In terms of comparative methodology, the study employs the ´most different systems design´ method (Otner, 2010), which enables a deeper understanding of differences in causal mechanisms to achieve a similar outcome. This analysis and methodology can inform exercises of ´lesson drawing´ (Benson et al. 2012) or ´policy translation´ (Mukhtarov, 2014) between European and Chinese decision-makers, managers and researchers interested in managing river basin social-ecological systems for sustainability and adaptability.

Empirical work enquired into how cross-sectoral collaboration is present in key sub-basin management processes (e.g. experimentation, planning, implementation, monitoring, and evaluation); what drivers lie behind collaboration initiatives; and what obstacles hinder the emergence of collaboration and its effectiveness. Information collection included analysis of primary sources such as rules, regulations, and management plans, as well as secondary sources such as academic literature and published research on water partnerships and collaborative environmental management. A series of semi-structured interviews was conducted to collect views and perceptions of key actors regarding the emergence and impact of cross-sectoral collaboration initiatives. In each sub-basin, 20 to 25 interviews were conducted between 2009 and 2011.

Three workshops were co-organised by the authors with the active participation of water managers and academic experts working on the selected case studies. Among other objectives, these events were also used to discuss perceptions on collaboration emergence and effectiveness. This enabled participant observation to occur. In the Chinese case study, non-participant observation was also employed as

access was granted to an internal meeting between river-basin managers and national-level policy-makers. In this way, we elicit evidence of the variety of ways in which collaboration takes form, providing a rich pool of information from which to understand possible drivers and modes of collaboration, and how they relate to impacts on the water environment.

The case studies

In this section we provide a brief introduction to each sub-basin, including key geographic information and water quality problems.

The Wupper sub-basin

The Wupper catchment is industrialized and densely populated with about 900,000 inhabitants covering an area of 813 km^2 in 2010 (Figure 2). The Wupper is a sub-basin district of the Lower Rhine basin district, as determined during the process of implementation of the Water Framework Directive of the European Union (EU WFD). It discharges into the main stem of the Rhine.[1]

In the past century the principal environmental challenge in the Wupper was the intense pollution caused by industrial units. Additionally, in summer, water quantity was insufficient to satisfy the demand of all water users. One of the key challenges today relates to the need to improve the ecological quality of rivers and streams as required by the EU WFD. A key problem in this respect has been diffuse-source pollution from agriculture (ATV-DVWK 2003). Cooperation across sectors is needed between the water and the agricultural sector as water supply companies within the water board have to invest heavily to treat reservoir water polluted by diffuse sources. Farmers' use of fertilizers in the catchment area of the reservoir has caused a decrease in the quality of its waters.

Figure 2. The Wupper catchment in the context of the Rhine River Basin

Source: Prepared by authors

[1] For basic information about the Wupper sub-basin see: www.wupperverband.de.

The Rhine-West sub-basin

The Rhine-West is one of the four river basin sub-districts in the Dutch part of the Rhine basin (Figure 3b). It has a surface area of around 12,000 km^2 and is inhabited by about 7.5 million people, nearly half the population of the Netherlands (RBO Rhine-West 2008).

Figure 3 (a) and (b): location of Rhine delta district and sub-districts (RBO Rhine-West 2008). Figure 3 (c) and (d): map of the Rhine West river basin sub-district showing the regional authorities responsible for the implementation of WFD except for the municipalities (RBO Rhine-West 2008).

Source: Prepared by authors

The main issues for the water system in the area, in the light of WFD requirements, are hydro-morphology and nutrification (RBO Rhine-West 2004). Rhine-West consists largely of land below sea or river level with man-made polder systems. Existing waterways have been greatly modified throughout centuries to ensure the safety of inhabitants or provide shipping routes. The nutrification is mainly caused by diffuse pollution by agricultural practices (around 50%) and waste water treatment in the densely populated areas (around 40%). Agricultural land use covers 60% of the area (RBO Rhine-West 2008).

The Xijiang sub-basin

The Chinese case study - the Xijiang (West River) sub-basin - is part of Southern China's Pearl River basin system. The sub-basin lies across four southern provinces (Yunnan, Guizhou, Guangxi, Guangdong), as well as the special administrative region of Macau located in the sub-basin's delta (See Figure 4). The Xijiang has a catchment area of 353,100 km^2, approximately 80% of the Pearl River basin, with a population of 63.67 million people at the end of 2012 (Pearl River Water Resources Commission, 2015).

Figure 4: The location of the Xijiang sub-basin in the Pearl River basin

Source: Prepared by authors

Since the late 1970s, rapid economic development has compromised water quality and ecosystems to different degrees in the various sections of the Pearl River basin. In 2008, 15% of the monitored sections, mostly located in the river´s lower reaches and deltaic system, were too polluted or too saline to be used as sources of drinking water. Surface water represents the drinking water source for most of

the population in the province of Guangdong (about 95 million people in 2009) and the adjacent special administrative regions of Hong Kong and Macau (with a population of around 7.4 and 0.6 million respectively in 2008) (Sadhwani et al. 2009). In 2007, approximately 16 million people lacked access to safe drinking water in Guangdong province (Yeung 2007).

In recent years, drinking water supply in the Xijiang sub-basin's delta has been compromised by seawater intrusion during the dry season from November to March (Luo et al., 2007). Drinking water supply in Macau and the municipalities of Zhuhai, Zhongshan, Guangzhou and Jiangmen has been seriously affected, especially since the year 2000. The operation of hydropower stations upstream and the difficulties in dealing with illegal sand dredging in the delta and lower reaches of the basin have been noted as key causes for this phenomenon (Zhang and Deng 2010).

Cross-sectoral collaboration in the Wupper

This section investigates how cross-sectoral collaboration in river basin management emerged and became institutionalized in the Wupper and how this helped solve complex environmental problems. Research in this section is mainly based on primary documents as well as on interviews with employees of the water board *Wupperverband*; with stakeholders in the catchment; and with those influencing the course of events at other scales (from state administration, industry, agriculture, environmental groups, water suppliers, municipalities and others).[2]

The institutional context

The *Wupperverband* was founded in 1930 to manage water pollution problems across municipal boundaries within this heavily industrialised and densely populated catchment. A so-called special law (*Sondergesetz*) enacted in 1930 by Prussia (and revised in 1992 by the German federal state of North-Rhine Westphalia) established the water board *Wupperverband* to regulate industrial polluters in the catchment to improve water quality. The main purpose of *Wupperverbandsgesetz* was and is to force diverse industrial actors into a binding framework across municipal borders, regulating pollution by industry and consumers. Presently the state of North-Rhine Westphalia and its administrative districts have the legal power to regulate water quality and quantity and to supervise the implementation of the EU WFD. However, the *Wupperverband* is in charge of daily river basin management and therefore

[2] Interviews were conducted in the course of two research projects carried out from 2009 to 2011 in the Wupper catchment (for more information see acknowledgement at the end).

cross-sectoral collaboration. The water board manages approximately 2,300 km of rivers and streams, and operates 12 reservoirs, 11 sewage treatment plants as well as structures for flood retention.[3]

The core objective behind the establishment of the *Wupperverband* has been to integrate all public authorities of the catchment (the regulators) and all industrial actors (water users and polluters) into one regulatory body. Membership of the *Wupperverband* is not voluntary; it is a legal duty for all water users, both polluters and other actors who benefit from the management of water quality and quantity. Ever since its establishment, the *Wupperverband* has regulated quantity and quality issues in parallel. *Wupperverband* can be considered a permanently institutionalized cross-sectoral collaboration.

Cross-sectoral collaboration between public and industrial actors takes place in the water board assembly (*Verbandsversammlung*) and its committees. Seats on the water board assembly and committees are distributed according to the water board law and the water board´s ordinance depending on the total amount of membership fee. Each member paying more than 1% of the total budget is allowed to send at least one delegate; other members have to form groups of delegates. As shown in Table 1, the water board assembly is largely dominated by the public authorities in group one. The second group consists of all groundwater and surface water users while water polluters are collectively represented in the small third group of members. Membership of the second and third groups partially overlaps as water polluters may also be users.[4]

Table 1: Groups of members in the Wupperverband assembly

Source: www.wupperverband.de

As mentioned, the number of seats attributed to each member organization in the assembly is linked to the annual membership fee, which constitutes the main source of funding for the water board.[5] Rules for calculating the fees are determined by a complex system with the aim to balance the interests of all water board members from different sectors. Two key joint management principles are in place: “joint responsibility” and the “beneficiary pays principle”. Funding of a wastewater treatment plant follows the joint responsibility principle, as all members pay for all of the water board’s treatment plants - not

[3] www.wupperverband.de.
[4] www.wupperverband.de.
[5] Other funding mechanisms – which do not follow the beneficiary pays principle – are only of minor importance in Wupperverband. The major funding mechanism has changed only slightly over the years; the latest small adjustment derived from new tasks required by the implementation of EU WFD. The basic principles were not questioned.

only for the treatment plant their sewage system is connected to. The beneficiary pays principle means that tariffs depend on the amount of water consumed and the amount of wastewater produced and its degree of pollution. In addition, the same principle means that a community located downstream from a reservoir has to pay a certain percentage of the total cost of the reservoir for its flood protection services. Public and industrial sectors are thus treated equally by this system of funding. Different calculations are made for dams and river management, but following the same core principles. As water users, citizens pay indirectly for water board fees given that public entities and utilities are members of the board.

All members of the water board (public and private) have agreed to supply water quantity and quality monitoring data according to fixed rules of the *Wupperverband* regarding format and timing. Both the members of the water board and the water board itself conduct monitoring and are required to report back to state authorities. In order to keep overall control, state authorities themselves conduct monitoring in parallel. This complex monitoring system is being further extended in accordance with requirements of the EU WFD implementation process.

Interviewees (from state administration, municipalities, industry, agriculture, environmental groups and others) largely perceive the institutional arrangement of the *Wupperverband* as being a transparent and effective cross-sectoral collaboration mechanism. Members from all sectors feel represented and integrated, largely on account of the consensus-based decision-making process set up by the board´s management.[6] The perception of these interviewees is that the current institutional arrangement (i.e. the *Wupperverband*) solves water quantity problems effectively. In regard to water quality problems, interviews argue that these can be solved within the same institutional setting if this is combined with strong emission control systems. In cases of non-compliance, the relevant laws and regulations can be legally enforced by the state of North-Rhine Westphalia and its administration.

Collaboration practices

As another instance of cross-sectoral collaboration in the Wupper sub-basin, local suppliers of drinking water (as members of the water board) and farmers in the catchment area have collaborated to

[6] The positive perception described seems to be connected to the culture of consensual decision-making introduced since 1997, when the *Wupperverband* got a new director. He succeeded in actively promoting consensus among all members, despite difficulties in changing formal decision making arrangements based on qualified majority voting. He effectively ended a period of more bureaucratic and hierarchical decision-making in the water board.

minimize non-point source pollution upstream of a drinking water reservoir. Collaboration has been institutionally organized in a very different manner to the one described above. It is based on the existing structures of the water board and the agricultural chamber of North-Rhine Westphalia. A so-called agricultural cooperation scheme (*Kooperation Landwirtschaft und Wasserwirtschaft*) has been set up around the catchment of the Große Dhünn-Talsperre, one of the largest reservoirs for drinking water supply in Germany. Collaboration between the water board and farmers has taken place for two decades on a voluntary basis. An advisor is employed by the agricultural chamber and paid by the water board to provide advice to farmers involved on how to avoid diffuse pollution without economic disadvantages; learn new fertilizing and sowing strategies and benefit from financial aid for new equipment. Drinking water companies are involved directly as local suppliers and indirectly as members of the water board (in the water users' category). Given that the cooperation scheme helps to decrease pollution levels (see figure 5 below), and it has thus reduced the cost of drinking water purification, local drinking water companies are the main funders of the scheme as members of the water board. The water board and the federal state of North-Rhine Westphalia also provides some of the funding. This collaboration scheme is also considered to be an important mechanism to reach the water quality goals of the EU WFD.[7]

According to *Wupperverband* in February 2012, 103 out of 107 farmers around the reservoir were participating voluntarily in this scheme. The few institutional arrangements needed for this collaboration consist of annual meetings; the hiring of the above mentioned advisor as permanent staff; and the designation of a contact person in *Wupperverband*. Furthermore, farmers involved continuously get reports on the monitoring data collected by the water board as well as by drinking water companies participating in the scheme. Figure 5 shows how the concentration of nitrates (NO^3), expressed in milligrams per litre of water, evolved in the period between 1991 and 2014. Since this form of collaboration started in 1993, seven years before EU WFD came into force, nitrate loadings to the reservoir were lowered by approximately 50%, from 17.40 mg/lt to 8.80 mg/lt.

As to the perceptions of most stakeholders interviewed, the agricultural sector appreciates the voluntary nature of the scheme; the expertise of the advisor - who is familiar with the farmers and is a farmer himself - and the economic incentives involved. Water suppliers within the water board cooperate mainly because of the economic incentive as the cost of treating water from the reservoir is significantly reduced. The water board itself benefits from this collaboration as some measures now

[7] http://www.wupper.nrw.de/Kooperationen/index.jsp.

foreseen by the WFD have already been implemented and actors involved share management experience.

Figure 5. Water quality in Große Dhünn Reservoir in the period between 1991 and 2014

Source: Spitz (2015)

When stakeholders met at round-tables during the course of the first WFD planning cycle, actors from the water and agricultural sectors already knew each other and shared positive experiences of collaboration. Consequently, round-tables moderated by *Wupperverband* have been considered useful by interviewees to identify WFD implementation measures. According to the water board staff and the river basin management plan proposed 2015, there is continuity in the processes of collaboration described and the measures proposed in the plan reflect this (MKULNV 2015). Overall, this experience of collaboration has been considered to be a potential model for future measures in the context of the WFD implementation in the catchment. However, questions have been raised about the extent to which newly agreed measures based on voluntary participation may succeed in effectively meeting the objectives set by the WFD.

In conclusion, the different types of resources made available for cross-sectoral collaboration in the Wupper catchment are generally considered by the *Wupperverband* and other stakeholders interviewed to have enabled positive outcomes. Key factors seen as responsible for the success of the *Wupperverband* itself include the legally enforced membership of the actors relevant for water quality and quantity management, and the sophisticated institutional model implemented (transparent and integrative decision-making and monitoring as well as fair financing). In respect to the collaboration with the agricultural sector, the main factors involve the voluntary nature of the collaboration scheme; transparent information exchange in respect to the effectiveness of measures; the zero cost approach and the problem-solving attitude adopted by the water board.

The findings also suggest that collaboration mechanisms to address issues of point and non-point pollution require different sets of incentives. Collaboration mechanism for point source pollution might require more top-down regulatory solutions while collaboration to address non-point pollution seems to require more bottom-up and voluntary approaches. This might be explained by the fact that non-point pollution loads tend to be smaller at each individual source, and there is an obvious difficulty in identifying pollution discharge points, in monitoring discharges and in imposing accurate discharge fees.

Cross-sectoral collaboration in the Rhine West

This section focuses on new forms of collaboration established during the process of implementing the WFD in the Rhine West sub-basin.

The institutional context

WFD implementation in the Netherlands is based on the principle that the organisational structure of water management and the competencies of the various authorities involved remain unchanged. The main water management tasks, safety against flooding, water quantity and quality management and waste water treatment, are performed by water boards and Rijkswaterstaat. The water boards manage the regional waters; they have the authority to develop local water management policy and local regulations. Separate elections are organised to form the water board councils and they levy their own taxes, providing their own budget. Rijkswaterstaat is the department of the Ministry of Infrastructure and the Environment that manages the state waters such as the main rivers, the North Sea and the large lakes. The municipalities collect sewage water, while the provinces are responsible for large groundwater abstractions as well as overseeing the municipalities and water boards.

As the WFD requires planning and management at river basin scale through river basin management plans (RBMP) - and no authorities exist at that level - coordination at river basin level is organised. In each of the river basin sub-districts a coordinating commission, or 'RBO' in Dutch, consisting of all the competent authorities in the sub-district was specifically established to coordinate WFD implementation (see Uitenboogaart, van Kempen et al. 2009; Junier 2010; Junier and Mostert 2011). In Rhine-West (figure 3) the authorities involved were the eight water boards; five departments of Rijkswaterstaat; the Ministry of Agriculture, Nature and Food Safety; five provinces and some 200 municipalities. Each RBO consists of the politically-responsible representatives of the member-organisations, and, in the case of Rijkswaterstaat, high-ranking policy makers. As drinking water is provided by non-profit companies; this sector is not represented in the RBO. The RBO is purely a coordinating body without any authority. The autonomy of each authority in the RBO is seen as crucial, because each has its own elected board and therefore democratic legitimacy. The RBO Rhine-West was supported by civil servants of the authorities in the RBO, who were allocated time (usually a few days a week) to jointly develop proposals for the RBO. They negotiated compromises based on their expertise, keeping in mind the positions of their respective boards. Each RBO was advised by a sounding board group consisting of societal stakeholders such as drinking water companies, nature or forest managers, farmers' organisations, environmental

groups, and recreational or professional fishery associations. The sounding board group for Rhine-West in the first planning period consisted of representatives of around 30 organisations.

The WFD planning process was organised on national, river basin (sub)district and regional levels, in parallel, requiring coordination between different areas and between levels (figure 6). The RBMPs were written by a national team of the Ministry of Infrastructure and the Environment, integrating the plans approved by the boards of the various competent authorities and the drafts drawn up by the RBOs. As part of this process each water board organised 'area processes' in their own areas to develop objectives for each water body, as well as the corresponding measures. In these processes both the competent authorities and organised stakeholders were involved, either in separate or in joint committees. Both the size and the structure of these processes of collaboration differed between and within water boards. In the Rhine-West sub-basin district over 40 'area processes' have been conducted (RBO Rhine-West 2008: 9).

The second planning period has proceeded along the same lines, although in some areas the process was somewhat less elaborate as the second period was viewed as an update to the existing plans.

Figure 6. National and regional planning process for WFD

Collaboration practices

In general, collaboration was seen as a requirement to implement the WFD successfully, as the directive specifically calls for addressing water quality and ecology at the basin-level. However, the different authorities had different roles in the implementation process. The water boards saw themselves as responsible for the local WFD planning process as they are responsible for water quality and were expected to implement and finance most of the measures. Rijkswaterstaat organised the process dealing with the state waters in a similar, although less elaborate way. The water boards and the Rijkswaterstaat, moreover, provided most of the required water-related expertise in this process. The provinces in general felt responsible for the RBO (i.e. regional) process as it was at a supra-local level and involved several water boards, many municipalities and other competent authorities.

Municipalities were initially not keen on joining the WFD implementation process as they did not recognise the Directive's relevance to their work. Therefore, in each water board area one municipal civil servant was appointed to be an intermediary, a so-called water ambassador, between the water board and the municipalities. The work of this official was funded by the national budget in the first years of the implementation process, after which national and local authorities shared the cost.

The RBO was based on consensus building, as is the norm in the Netherlands. Although the decisions arrived at are not binding, they were generally taken very seriously by executive councils of the participating organisations and the advice was mostly adopted in binding programmes and plans. This was facilitated by the professionals who developed support for the proposals, inside and outside the organisation, before submitting them. The fact that decision-making was limited to the competent authorities that were members of the RBO, however, was one of the hindrances for developing measures beyond these organisations.

The sounding board groups were a means to inform and consult civic society, to determine which measures were accepted or contested. Our interviewees pointed out that the conflicts in sounding board groups were generally, and not surprisingly, between farmers associations and nature-management organisations and/or environmental associations. One of the comments made regarding the role of sounding board groups was that these were purely based on protecting interests and did not lead to fundamental discussions on what objectives were considered important to strive for (c.f. Van der Arend and Behagel 2011).

The agricultural sector has been involved in all levels of planning, but only a few measures were taken that involve the agricultural sector. The regulations regarding agriculture are established at the national level where it was decided that the WFD should not add constraints to farmers practices over the norms set by the Nitrates Directive, for which the Dutch have successfully requested exemptions to meet the deadlines. Local authorities have few competencies to impose further restrictions on agricultural practices; measures for WFD are therefore predominantly taken by water management authorities (Junier and Mostert 2011). These mainly include improvement of waste water treatment and hydro-morphological measures such as bank re-naturalisation and installation of fish ladders. Nevertheless, parties at the local level can agree to go beyond legal requirements and voluntarily participate in projects to improve water quality and ecology, as some examples show. The water board Hollands Noorderkwartier (HHNK), for example, organised a working group that included farmer organisations, the neighbouring water board Rijnland and the local environmental office[8] in order to address specific water quality issues related to flower bulb growing. It resulted in joint experiments to reduce the impact of the sector on water quality to be executed in the first round of WFD implementation

[8] Local municipalities work together in the field of environmental protection through an environmental office executing joint policy (including issuing of permits, monitoring, and fines).

(Hoogheemraadschap Hollands Noorderkwartier 2008). A number of water boards have adopted a policy for the payment of green-blue services. These are services landowners may voluntarily supply, such as maintenance of 're-naturised banks' that extend beyond legal requirements and can therefore be subsidised by water boards. Although the concept existed before, this will now be implemented at a larger scale.

In the second planning period there are concerns about being able to reach the WFD goals in 2027 and about how to regulate and fund the necessary measures in the agricultural sector, as parliament blocks compulsory measures that would cost famers money and subsidies are not allowed in the European context on the grounds of unfair competition. The water management sector is therefore collaborating with the agricultural sector in the Delta plan for agricultural water management. The Ministry of Infrastructure and the Environment subsidizes studies and experiments to develop agricultural practices that would contribute to reaching WFD goals. The proposed measures in this Delta plan are all voluntary and it is unclear at this time what their effect will be (Planbureau voor de Leefomgeving 2015).

The central role of water boards in the implementation of the WFD required them to collaborate much more with other boards within the same river basin (sub) district and with other competent authorities and organised stakeholders than before. The interviewees, the Rhine-West evaluation (Org-ID and Bureau KLB 2008) and the national evaluation (Heuvelhof et al. 2010) all stress that this collaboration was very valuable, both directly to the development of the plans related to WFD implementation and to other water management related processes. The fact that the parties involved have come to know and trust each other is considered of great importance. However, the new collaborative planning processes such as RBOs and sounding boards were, in general, not able to commit the parties to new measures addressing the important issue of nutrification and its agricultural sources. Also unresolved were a number of upstream-downstream dependencies with negative consequences for water quality and ecology. They have been postponed to the next round of planning.

Interviewees have highlighted that collaboration processes have benefited from certain human, technical and financial resources made available. The number of experts involved in the planning and consultations was calculated to be about 1500, very high for an individual planning process in the Dutch context. The national government made funds available to support the payment of water ambassadors in municipalities to encourage more active participation from their side. A synergy fund provided additional resources for authorities to undertake measures jointly, while an innovation fund was established to promote experimentation and increase knowledge on novel measures. Furthermore,

technical tools to support the implementation process were developed by national organisations with the input of regional and local authorities.

Overall, the Dutch case shows a combination of bottom-up collaboration as part of local area processes and proposal generation developed through consensus, and top-down steering in what concerns the form and timing of planning process and funding provisions.

The Xijiang (West River) sub-basin

This section discusses collaboration among different sectors of administration and economic activity in the Xijiang sub-basin. New collaborative processes are emerging to counteract and respond to the problem of seawater intrusion in its delta, and the resulting lack of drinking water security.

The occurrence of seawater intrusion has been attributed to a combination of factors: drought; water storage in reservoirs in the upper reaches; sea level rise; increasing water consumption; and illegal sand-dredging in river channels (Luo et al. 2007; Zhang and Deng 2010). Illegal sand dredging has significantly contributed to down-cutting the river bed in certain areas on the Xijiang by about 7 metres, increasing the upstream penetration of seawater at high tide (Luo et al. 2007). These multiple factors relate to decision making processes in sectors such as the ministry of water resources and its regional and local departments, hydropower state companies, and the ministry of housing and urban-rural development and its local departments.

The institutional context

Given the difficulty of constructing sufficiently large reservoirs in the river's deltaic system, the problem of drinking water supply volume in the Xijiang has been curbed by large and calculated releases of water from upstream reservoirs constructed for hydropower production. Since the dry season of 2004, the water transfer scheme has ensured that water from upstream reservoirs is released during the dry season to compensate for low flows downstream and to enable the refilling of drinking water storage reservoirs in the delta. Since 2004, eight water transfer operations were conducted in the Xijiang to ensure water supply in Macau, Zhuhai and Zhongshan. These operations are now regulated by the "Special Plan to Ensure Water Supply to Zhuhai and Macau" approved in March 2008, and the "Comprehensive Plan of Water Resources in the Pearl River Basin" approved in May 2011 as means to implement the national Water Law, last revised in 2002. The "Pearl River Water Resources Scheduling Regulation" was also approved al by China's State Council.

The sectors and departments involved in the "water transfer scheme" are the State Flood & Drought (F&D) Headquarters, the Pearl River Basin F&D Headquarters, and the F&D headquarters in the provinces of Guizhou, Guangxi and Guangdong; the state-owned company "South Grid"; and local hydropower engineering companies who operate the actual scheme in conjunction with the Zhuhai municipal government. The State Headquarters receives orders directly from the State Council but has operational offices along the Ministry of Water Resources (MWR) administrative hierarchy.

Collaboration practices

The decision to release water from upstream reservoirs is usually subject to two types of consideration. The first is technical and relates to the optimum pressure in the reservoir at the time of release. The higher the water levels, the higher the pressure and thus the more energy that can be produced. The second is economic and relates to the period of time with the highest demand from industrial producers. January and February are less energy-demanding months given that industrial production comes close to a halt during Spring Festival celebrations when migrant workers return to their hometowns for about three weeks. These two considerations seem now to be overridden by higher administrative orders issued to implement the "water transfer scheme". Given state ownership status, the energy companies' lost revenue may be covered by additional funds from its government shareholders.

The hydrological department of the Pearl River Headquarters sets the requirements of the water transfer scheme after discussions with the city of Zhuhai regarding water supply challenges. This Headquarters will then request approval of the transfer scheme designed from the State Office. Upon approval, they inform the F&D headquarters in the provinces of Guizhou, Guangxi and Guangdong, as well as state-owned companies such as State Grid and Guangxi Grid about their responsibilities for implementation. Furthermore, the Pearl River Headquarters mediates between these actors and the Zhuhai municipal government, which is the sole supplier of drinking water to Macau, in implementation meetings where details are discussed and specific responsibilities confirmed. The Pearl River Headquarters may also convene separate meetings with the Zhuhai municipal government to discuss water storage and water supply to Macau and exchange information, given the higher political status enjoyed by the territory within the state hierarchy. During implementation, the Pearl River Headquarters supervises the scheme, and updates the water discharge requirements according to hydrological forecasts.

In addition, the Pearl River Water Resources Commission (Pearl River Commission), which is effectively a regional branch of the MWR, has prepared a project to build a new reservoir to be located in the province of Guangxi. This project – the Datengxia Dam – was designed in collaboration with the governments of the provinces of Guangxi, Guangdong and Macau SAR. The reservoir will be managed directly by the Pearl River Commission with the main purpose of compensating low flows in the dry season. Figure 7 illustrates the potential impact of the dam in fighting seawater intrusion. The most northern line represents the salt tide intrusion limit under the present water utilization and P=98% precipitation situation. The most southern line represents the estimated salt tide intrusion limit under P=98% precipitation situation once the Datengxia project is operational. At the end of 2015, the dam´s construction remained under preparation.

Figure 7. Seawater intrusion in the Pearl River Delta

Source: “Special Plan to Guarantee Water Supply Safety of Zhuhai and Macau”

This suggests that a key form of collaboration in the Xijiang is the organisation of negotiation-oriented meetings on a case by case basis. Nevertheless, regulations and administrative orders have a prominent role in the implementation of the scheme. The focus is on remediation and minimisation of the impact of sea water intrusion. There is apparently insufficient cross-sectoral collaboration to address the anthropogenic sources of the problem and actively prevent environmental degradation. In particular, there seems to be insufficient coordination between the ministry of water resources and the ministry of housing and rural-urban construction at national level to attempt to curb illegal sand-dredging activities in sensitive areas.

A special management plan has been put in place in the province of Guangdong to define functional zones where is allowed or prohibited. The plan has no binding status however, and imposition of meaningful sanctions on violators of the functional zone requirements has not been possible. Collaboration from other departments could be facilitated by the inclusion of functional zones in a higher level provincial law, and this might also provide a basis for sanction those who dredge illegally. Another possible explanation for this, which requires further investigation, is that the implementation of legislation on the dredging of river sediments, and the ensuing practices of inspections, may be hampered by informal structures of authority, as seen in the case of the implementation of environmental legislation by the Environmental Protection Departments in certain localities. Tang et al

(1997) and Lo et al. (1994) identified occasions when inspections were impeded on account of the higher administrative rank of company directors within the government system.

In any case, the current environmental legislation is considered too weak to ensure effective and systematic collaboration between the water sector and other sectors at river basin scale. Formal collaboration on monitoring, planning and legislation is limited given that there are no funding mechanisms available for cross-sectoral work. However, the Pearl River Commission has occasionally been able to activate informal relational networks based on kinship and trust (traditionally denominated as *Guanxi* 关系) to access the data and information collected by agencies under the control of other ministries but crucial for the Commission to carry out its tasks.

The problem of seawater intrusion in the Xijiang has presented one of the most pressing challenges for river basin managers in the Pearl River, given the public health implications in one of the world´s most densely populated urban deltas. It has also exposed new interdependences between downstream and upstream stakeholders, and the importance of cross-sectoral collaboration to address these interdependences in a sustainable way.

A comparative analysis

Collaboration among different sectors of administration and/or economic activity is an important requirement for IRBM. However, as the cases above illustrate, various factors drive and constrain cross-sectoral collaboration. Tables 2.a and 2.b present a simplified and comparative view of those factors, in light of the analytical framework presented in figure 1 (see introduction). This section presents a comparative analysis on two levels: (a) between the Chinese and the European case studies; (b) between the European case studies themselves.

The proposed analytical framework proved useful in teasing out similarities and differences between the cases in respect to factors influencing the emergence of collaboration and its effectiveness. An important finding was that incentives put forward by higher level governmental actors were instrumental in bringing about collaboration among local level governments in the selected sub-basins (i.e. in the Chinese case, the Flood and Drought Control Headquarters; in the European cases, the European Institutions, plus the Ministry of Environment in the German State of North-Rhine Westphalia; and the then Ministry of Transport, Public Works and Water Management in the Netherlands). In each case, higher level governmental actors were directly involved, in one way or the other, in driving processes of issue definition, distribution of resources, and decision-making procedures. When it comes

to the workings of collaboration on the ground, however, the role of higher level governmental actors was very different in each case.

Table 2a - Factors influencing collaboration in the selected case studies
Table 2b - Factors influencing collaboration in the selected case studies (continuation)

In the Chinese case, national and local governmental actors acted in response to a drinking water crisis and decided, for the first time, to coordinate action between the water and energy sectors across the Xijiang sub-basin. The problem was framed by governmental actors as a problem limited to the dry season and possible to address through the coordinated operation of reservoirs managed by state hydropower production companies. The impossibility of building more reservoirs in the delta, along with the political status of the Macau SAR, provided a strong impulse for action. Collaboration was enabled by hierarchic administrative power relations with the Flood and Drought Offices, led by one of China´s Vice-Premiers, requesting State hydropower companies to release water from reservoirs in the upper reaches of the catchment at specific times. There were no specific financial arrangements supporting the mobilisation of human and informational resources for this purpose. The operation of the "transfer scheme" at a new spatial scale (i.e. the sub-basin) seems to be a success based on *ad hoc* collaboration. Overall, the presence of effective collaboration seems essentially dependent on two drivers: top-down administrative power and personal networks enabling actors to activate kinship relations and thus facilitate collaborative implementation on the ground.

When contrasting this with the findings in the European case studies, we can find a gradation in the way that central governments and top-down political and administrative power is exercised to guarantee new practices of cross-sectoral collaboration among governmental and non-governmental actors at catchment scale. In the German case, the state of North-Rhine Westphalia plays an important role by making it mandatory for different water users and polluters to be members and collaborate in the *Wupperverband*´s work. Moreover, the state monitors both the water bodies and the water board´s progress in the implementation of legal requirements. The collaboration led by the water board is perceived to have been very successful to address point-source pollution, being supported by fair co-financing arrangements securing the availability of relatively abundant human and informational resources. There are also promising outcomes in respect to collaboration to address non-point source pollution as far as the protection of drinking water sources is concerned. The voluntary basis of the measures addressing non-point source pollution responds to a clear market demand: drinking water companies save on treatment costs when farmers adopt measures to control pollution from nitrates and phosphates in the catchment of a strategically important reservoir. A client-provider relationship emerged from mutual interest in raising incomes. However, the implementation of the WFD reframes water quality problems and goals by requiring the achievement of good ecological status in all water

bodies. While this requires mandatory measures, it is unclear how these will be met by the agricultural community and how funding to achieve goals will be secured. Nevertheless, the presence of trust through decades of collaboration is maintaining optimism within the *Wupperverband*. Ongoing information exchange on the effectiveness of measures and the employment of farming advisors who are themselves farmers has also been shown to contribute to positive outcomes in this regard.

In the Dutch case study, the role of the central administration in promoting and organising cross-sectoral organisation at catchment scale appears to be weaker and to derive from the obligation to implement the WFD. It seems to be a political endeavour in which the central government actors have less authority to push action forward, not least because the WFD is often seen as an unwelcome imposition from the European Union. Dutch water boards have a strong autonomy deeply rooted in history. The boards are locally elected and hold the right to raise tax to fund their work. The high autonomy and legitimacy of water boards´ decisions posed limitations to the power of the central administration during the first cycle of WFD implementation process. Central governmental actors felt the need to actively promote political venues for consensual decision-making processes at different spatial scales, including, for the first time, in sub-basin districts. National level governmental actors also provided new financial and human resources for the strengthening of linkages between local actors, such as the funding of water ambassadors linking municipalities with water boards. The decision to appoint ambassadors that are staff of municipalities reveals a strategy to make use of established professional and personal trust to circumvent resistance from within municipalities. All in all, the Dutch cross sectoral collaboration at catchment scale has been essentially a non-binding and consensus-based mechanism, fitting the Dutch decision-making culture. However, lack of policy coherence in the interpretation and implementation of different European Directives, namely the WFD and the Nitrates Directive, is presenting difficulties for cross-sectoral collaboration to address issues of diffuse pollution from agricultural sources.

In both the Chinese and the Dutch cases, there is a rescaling of collaboration processes from the administrative to the hydrological scale promoted by new problem framings. In the Chinese case, the problem framing seems to originate from the local level of the administrative scale, as Macau and Zhuhai asked for the help of provincial and national government to address a drinking water crisis. In the Dutch case, the perception of many stakeholders is that the spatial scale of action at which to address their water management issues is being re-framed primarily from the top and in order to satisfy European requirements. In the German case, there was a sense of continuity in scaling practices but

with higher ambitions in the sense that the water quality problems were re-framed as problems of the freshwater ecological system. Partners in collaboration processes build on long term relations of trust at sub-basin scale in order to advance new objectives set at the European scale. Being a better fit with the institutions in place, this new problem framing caused less controversy in the German case than in the Dutch case. In terms of availability of resources for collaboration, it seems clear that funding, human and informational resources are more abundant in the European case studies than in the Chinese case study, where lack of funding, insufficient human resources and data sharing problems hinder collaboration. This seems, however, to be a result of lack of political will and leadership beyond urgent issues of flow regulation. As the Pearl River Water Resources Commission (Ministry of Water Resources) has no official role in promoting cross-sectoral collaboration, its role is very limited in this domain. In the European cases, financial, human, technical and informational resources are, in comparison, more abundant but the decision to employ them in the pursuit of new WFD goals is not straightforward, particularly in the Dutch case.

In terms of the decision making processes and group structures, the effectiveness of collaboration seemed to depend, to a large extent, on the informal rules and social practices embedded in the political, legal and administrative cultures. In the Xijiang, actors rely on the authority of administrative hierarchies to guarantee implementation and accountability. But there is a less visible side of water management – personal networks are fundamental to support bargaining occurring during implementation. In the Chinese context, informal institutions permeate all levels of administration and facilitate exchange of important information as well as decision-making. This seems to contribute to an improved capacity to monitor and understand catchment environmental processes (Silveira 2014). In addition, personal networks have played important roles in the bargaining processes determining how laws and policies are to be ultimately implemented by local governments (Zheng 2006).

In the European context, informal mechanisms are also important but in a different way. Our findings identify the influence of professional (as opposed to personal) networks as facilitators of implementation and decision-making in both the Dutch and German cases. Consensus building becomes the norm, and professionals at the various authorities have certain freedom to prepare a compromise based on proven expertise. Nevertheless, collaboration at catchment scale in the Dutch case is less institutionalized than in the German case, and traditionally more reliant on a consensus based culture, backed by the common knowledge that failure to reach consensus will mean imposition of measures by the national government. The German system seems to display more formalised rules (e.g. majority

voting in the *Wupperverband* assembly) and greater reliance on administrative and legal procedures but these rules may also be put aside if processes of consensual decision-making and trust are seen as more effective to bring about collaborative work. There is therefore a certain amount of convergence in the way that informal institutions and actor networks are being harnessed across all cases for collaborative implementation processes that are adjusted to local needs and conditions.

Finally, this analysis also reveals how the factors put forward in the framework (e.g. issue definition; availability of resources; decision group structure and decision-making procedures) appear to be closely inter-related and clearly influence each other. Evidence also shows how this bundle of factors is being influenced by the wider institutional context of formal and informal rules.

Conclusions

Further developing the analytical framework proposed by Koontz et al. (2004), this article examines factors driving and constraining effective cross-sectoral collaboration in river basin management, with a focus on organizations addressing water quality challenges. We draw on findings of three case studies embedded in different social, political and economic contexts, themselves very different from the North American context in which this framework was first applied. This section examines the usefulness of this analysis when researching other cases and points out directions for further research.

Our findings highlight various mechanisms through which the wider formal and informal institutional context influences more proximate factors identified by Koontz as underpinning effective collaboration among relevant actors at catchment scale: issue definition, availability of resources, decision-making processes and group structure. Although it may be natural that sets of formal rules dictate the availability of human and financial resources, and indeed information and knowledge that feed and sustain collaborative action, the underlying interplay between these rules or institutions, and how it enables or constrains collaboration initiatives at catchment scale, is less well understood. This institutional interplay is both vertical (referring to interplay across levels of social organization), and horizontal (across policy arenas at the same level).

Considering these three case studies, it seems clear that the traditional vertical interplay between rules set at the administrative scalar dimension (national ministries, provincial authorities, municipalities) holds a decisive role in enabling collaboration among actors at hydrological scales, which typically cross administrative jurisdictions. The interplay between national/state level governmental rules/organisations, and those at lower levels in the administrative scale, contributes to the definition of

environmental problems and decisions about: the spatial scale at which to address them; what resources should be mobilized; what decision-making processes should be followed; and who should participate in them. This link between the organisation of cross-sectoral collaboration at catchment scale and institutional interplay at the administrative scale is evidenced when, for example, horizontal policy incoherencies within the administrative scale are reproduced in collaborative arrangements, hampering their effectiveness. Higher level formal rules and regulations enacted by the state and its actors also play a central and enabling role when determining, for example, whether monitoring data and related information is exchanged systematically or co-funding arrangements are put in place at catchment scale.

Findings from the European case studies reveal that, through the WFD implementation process, the EU is effectively promoting new or deeper processes of negotiation across sectors at the biophysical scale. These processes emerge from a recognition of the complexity of water-land interactions and the acknowledgement that it is not possible for water managers and their organisations to achieve the directive´s ambitious goals without the collaboration of stakeholders in sectors such as spatial planning and agriculture. The demanding requirements of the WFD seem to be contributing to the activation of personal and professional networks in the aid of consensual decision-making processes and, as far as agriculture is concerned, legally non-binding agreements. This resonates with the findings of Koontz and Newig (2014) on the importance of social networks in promoting effective and collaborative implementation of catchment plans in the EU.

The importance of informal rules emerges strongly in all case studies. The role of inter-personal trust and the predictability of the legal-administrative system particularly stand out as factors influencing the emergence and continuity of collaboration. Socially embedded practices play a fundamental role in, for example, access to data, information and knowledge available on a given water quality problem. This reinforces the importance of legally non-binding reciprocal and collaborative processes when attempting to bridge political interests emerging from different knowledges and geographies.

Findings also reveal the inter-connectedness *between* the proximate factors impacting collaborative arrangements identified by Koontz and colleagues (2004) (i.e. issue definition, including problem framing and spatial scale, availability of resources, and decision-making processes). This acknowledgement facilitates an important link with critical human geography literature on the social and political construction of scale in environmental governance (Moss and Newig 2010, Cohen 2012, Cohen and McCarthy 2014, Hüesker and Moss 2015). An environmental problem is framed as having a

particular spatial and temporal scale also as a result of resources available (data, information and knowledge made available through adequate human and financial resources), the features of the decision processes in place and how inclusive these decision-making processes are. In this sense, we see actor networks and informal institutions influencing the way in which these proximate factors interact, not least because of their influence on the availability of data, information and knowledge. We did not find solely non-governmental initiatives at catchment scale in our case studies. The role of state actors appeared in fact to be dominant, including in the framing of environmental problems. This aligns with the work of others who argue that, when it comes to the role of the state in environmental protection, the 'hollowing out of the state' is far from complete (Reed and Bruyneel 2010). In the Chinese context, this is less surprising. However, it is important to note there is a trend of locally driven collaboration among a number of (semi-)governmental stakeholders with divergent interests, as also shown in previous research on the Pearl River and the Xijiang sub-basin (Silveira 2014). All in all, even within an increasingly polycentric system of natural resource governance, with increasingly important roles for market and civil society actors (McGinnis and Ostrom 2010), the state holds decisive cards both in the Chinese and European contexts, albeit in different ways.

Our findings do not offer generalizable evidence of causal relationships, and could not attempt to do so given the design of the investigation. Nevertheless, the `most different systems design´ method used allows the identification of some commonalities under otherwise very different circumstances, thus suggesting factors and dynamics worth investigating in any river basin governance system, regardless of their physical, human and political geography. In this light, our research identifies parallels in the way that socially embedded institutions and actor networks (governmental and non-governmental actors) influence processes of problem framing, decisions about the scale of decision-making and institutional interplay. We argue that these factors and dynamic processes are important in any process of cross-sectoral collaboration in river basin management. Naturally, the way in which these factors and processes translate into practice varies in accordance with the social, political and ecological characteristics of each case.

These findings may be used as sources of hypothesis in future in-depth case study analysis. For example, research could attempt to gain a deeper understanding of how cross-sectoral actor networks may be crafted and energized, through combinations of instruments and incentives of different nature (e.g. regulatory, market and civil society), to promote effective collaboration at catchment scale in different social, economic and political conditions. In addition, the proposed analytical framework may be useful

for further comparative analysis with a view to diagnose the potential of, and limitations to, ´policy learning´ or ´policy translation´ between river basin social-ecological systems. Our findings do not support simplistic transfer or transplantation of policy solutions, but the identification of important factors and processes to consider when crafting new incentives for, or removing constraints to, cross-sectoral collaboration for sustainability in river basin management.

As to the nature of socio-environmental problems studied, the analysis of these case studies highlights the importance of research into the water-food-energy-climate nexus. Solutions to the water quality problems that emerged from the Chinese case study relate directly to trade-offs between water and energy. They are particularly relevant to fast urbanizing deltas across the world at a time when the construction of hydropower dams is gaining popularity (partly as a climate adaptation mechanism) but sea level rise continues. It is important, in this regard, to further consider the politics surrounding the definition and protection of environmental flows. The European cases highlight the problems many western developed countries have with very high levels of agricultural diffuse pollution. Problems of policy coherence and institutional interplay among different policy arenas (in this case, water, agriculture and regional development), alongside contradictions between public policies, government regulations and standards set by market actors also constitute a crucial area for further research.

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