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Societal Drivers of European Water Governance: A Comparison of Urban River Restoration Practices in France and Germany

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Abstract: The European water governance took a decisive turn with the formulation of the Water Framework Directive (WFD), which demands the restoration of all water bodies that did not achieve sufficient ecological status. Urban rivers are particularly impaired by human activities and their restorations are motivated by multiple ecological and societal drivers, such as requirements of laws and legislation, and citizen needs for a better quality of life. In this study we investigated the relative influence of socio-political and socio-cultural drivers on urban river restorations by comparing projects of different policy contexts and cultural norms to cross-fertilize knowledge. A database of 75 projects in French and German major cities was compiled to apply (a) a comparative statistical analysis of main project features, i.e., motivation, goals, measures, morphological status, and project date; and (b) a qualitative textual analysis on project descriptions and titles. The results showed that despite a powerful European directive, urban river restoration projects still keep national specificities. The WFD drives with more intensity German, rather than French, urban river restoration. This study showed the limits of macro-level governance and the influence of micro-level governance driven by societal aspects such as nature perception and relationships between humans and rivers.

Keywords: human-nature-relationships; restoration targets; riverine socio-ecosystems; urban ecology; Water Framework Directive

1. Introduction

Water governance refers to political, social, economic, and administrative systems that intend to improve water resource management [1]; for example, promoting sustainable development of water resources and services. In an urban context, rivers have been pervasively modified for various uses and to reduce flood risks [2,3]. This development has resulted in severe ecological dysfunctions described as the "urban stream syndrome", which is characterized by flashier hydrography, elevated concentrations of nutrients and contaminants, altered channel morphology, reduced biotic richness, and increased dominance of tolerant species [4]. River restoration aims to re-establish ecological functions of running water ecosystems [5–7]. According to the definition formulated by Clewell [7] a broad spectrum of restoration activities, e.g., rehabilitation, reclamation, and revitalization, are gathered under the term

"restoration" and differ in their ecological quality goals. Urban river restorations (URR) generally need to integrate ecological goals, physical constraints [8], flood protection for close-by areas, as well as increasing demands for recreational uses by citizens [9,10]. URR are motivated by multiple ecological and societal drivers, especially (a) governmental interventions setting new requirements of legislations and laws, such as the ecological quality goals demanded by the Water Framework Directive [11,12]; and (b) citizens' increasing demands for a better quality of life, e.g., improvement of the recreational potential of the riverine area [11]. While many urban river restoration projects have been initiated [13,14], a review of published articles from the Web of Knowledge carried out by Francis [15] showed that scientific studies on urban freshwater body restorations remain rare, especially in the case of major cities. However, the publication of feedback is an important issue to fertilize restoration governance, sciences, and practices. When studies on URR exist, they focused on the success of the restoration in terms of ecological recovery [16] and chemical quality improvement [15]. Little concern has been given to societal aspects [17–19], e.g., how social, cultural, recreational, political, and historical contexts influence water governance and practices in the case of urban river restorations.

The European water governance took, in 2000, a decisive turn with the signature of the Water Framework Directive (WFD). The WFD is one of the most ambitious environmental legislations [12,20] and intends to ensure a good ecological quality [21] of all water bodies inside the European Union, considering biological, hydro-morphological, and chemical characteristics. However, the European political landscape is heterogeneous. Authorities in each European member state incorporate rights and obligations of European directives into their own law. Historic-cultural differences are important inside Europa and each country has developed in the past its own policies for slightly different purposes [22,23]. Hence, Europe showed a wide variation of water governance, e.g., policies, before and after the WFD came into force [20,24,25]. This background suggests that, despite the fact that the WFD is a powerful tool, it may differently influence the national water governance failing in homogenizing the restoration effort. The understanding of the country-specific differences of water governance may help to cross-fertilize systems, and to formulate effective E.U. policies.

Cross-national comparative research is an effective tool to understand different societal responses to common issues [26], and to cross-fertilize knowledge [27]. This study investigates the variability of URR in different policy and cultural contexts by choosing the cases of projects in major cities in France and Germany to (a) cross-fertilize knowledge; and to (b) investigate the influence of macro-level water governance on micro-level restoration practices in these European countries. The comparison between France and Germany is particularly interesting since they both have a long-standing tradition of restoration and, therefore, a large number of projects. Furthermore, they developed in the past similar strategies in environmental policies as, for example, in flood risk reduction [22]. However, major differences exist. First, a Europe-wide comparative study showed that fundamental parts of landscape planning policies and landscape approaches differ between France and Germany [28]. German approaches are usually more ecologically-oriented than French, which underscore human needs and usages. Social concerns and cultural understanding of nature also differ between both countries [26,29,30] and influenced the formulation of planning strategies, as well as the design and management of urban green spaces [31–34]. Studies showed that, in France, citizen preference for controlled nature is higher than in Germany, where urban parks have a more natural design comparing, for example, major parks in Paris and Berlin [30]. Since urban riverine areas are commonly used as urban green spaces, urban river restoration practices may also mirror this difference of nature preferences. Accordingly, we expect to find, in France, restoration projects of the "rehabilitation" type, according to the definition formulated by Clewell [7] namely focusing on the reestablishment of ecosystem processes, productivity, and services, whereas German projects may target a more ecologically-oriented river restoration. Additionally, water governance prior signature of the WFD differed between the countries, e.g., concerning water quality control policies [23], and different river management and planning strategies [20]. These differences may have contributed to the achievement of different river ecological status at the date of the ecological inventory of European freshwater

in 2004 [35]. Different river status in the past may influence the current river restoration strategy. The understanding of country-specific and historical-cultural influence on the restoration practices may provide valuable information for further development of the water governance strategy avoiding disconnection between policy, practices, and governance.

Accordingly to this background, this study aims to investigate the limit of the common framework caused by the influence of socio-cultural drivers on national water governance by comparing urban river restoration projects in France and Germany. We hypothesized that, despite a common framework orchestrating the ecological restoration of the European rivers, between both investigated countries: (1) the driving forces for the restoration effort, e.g., the influence of the WFD, differ; (2) the restoration approaches differ, namely, that the German approach may be more ecologically-oriented than the French, which may be more human-oriented, mirroring higher preferences for nature-control; and (3) antecedent conditions influence different restoration strategies.

2. Materials and Methods

2.1. Sampling of Restoration Projects

The study has been carried out on all the German and French major urban areas (n = 132) with population sizes larger than 100,000 inhabitants at the last demographic census; in France, counted in 2013 and published online via the Institut National de la Statistique et des Etudes Economiques [36] and, in Germany, counted in 2011 and published via the Statistisches Bundesamt [37]. Since existing cross-national databases of river restoration projects were highly fragmented, often relying on voluntary entries, and contained poor information about URR, we collected data through direct phone interviews. We identified 153 contact persons, i.e., stakeholders or officers in regional urban planning agencies, water management offices, river basin district offices, local governments, staff of consulting or planning firms, and non-governmental organizations, using the staff listing of river basin districts and city governments. We asked them if urban river restorations have been or will be implemented into the 132 urban areas and if they could provide contact information. The overall response rate was 65% (Table 1). We found that more than a half of the surveyed major urban areas (>58%, at least n = 76) had implemented URR. However, considering the cities which did not participate to the survey may also have implemented a project, the urban river restoration effort could reach 90% of the French and German major urban areas. We recorded all of the projects with no prior judgment about their legitimacy as restoration following the approach used for the U.S. river restoration survey [13]. Only implemented projects, or those in an advanced state of planning, were recorded. We established a database of 75 URR implemented between 1980 and 2015 (Figure 1, Table A1), namely 32 French urban river restorations (FURRs) and 43 German urban river restorations (GURRs).

Table 1. Overview of the participation rate at the survey.

Country	Number of Urban Rivers	Number of Cities with URR		Number of Cities without URR	Number of Cities without Answer
France	n = 53	n = 32	60.37% of French urban rivers	n = 10	n = 11
Germany	n = 79	n = 43	54.43% of German urban rivers	n = 1	n = 35

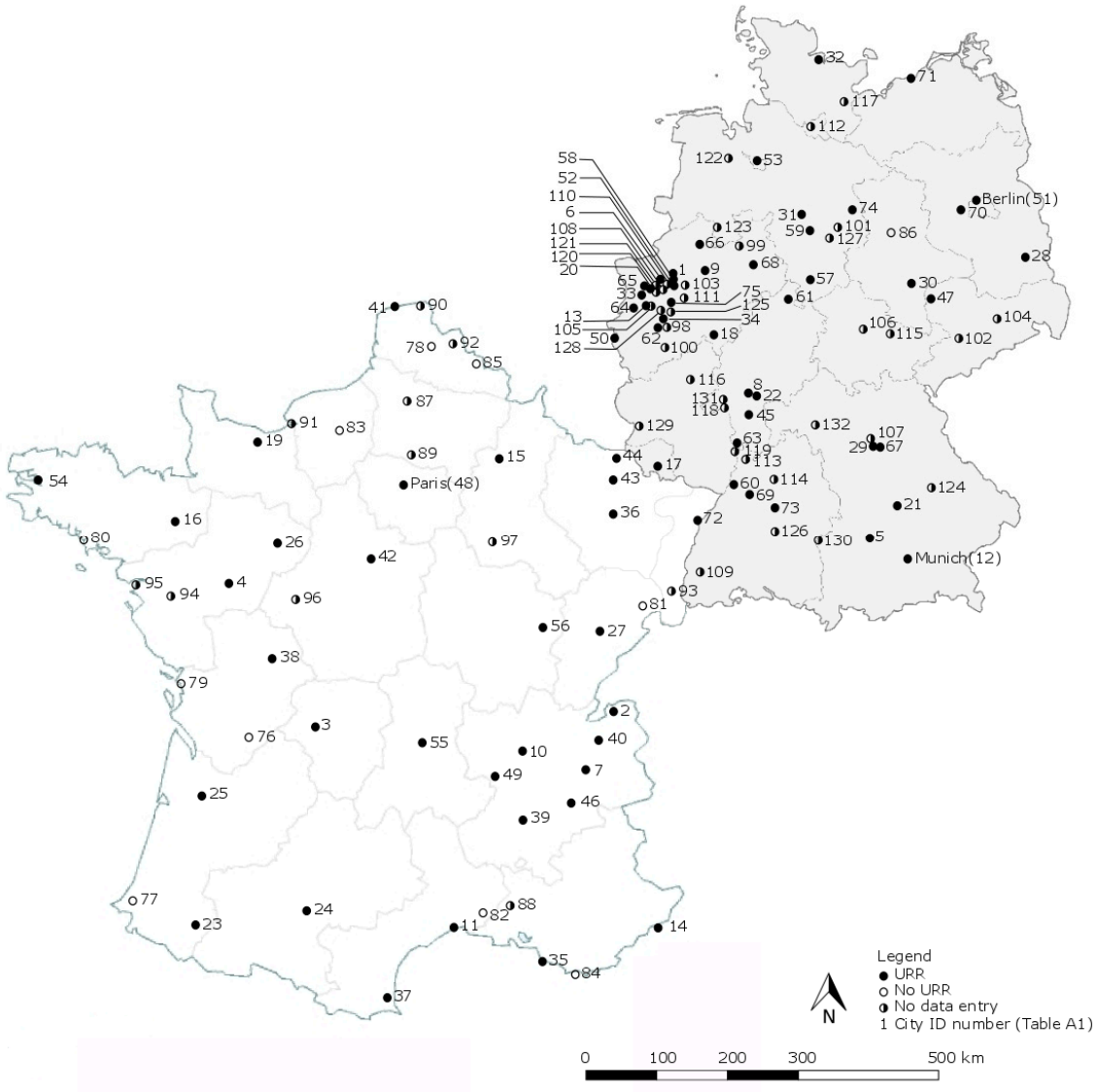

Figure 1. Map of the 75 urban river restorations (URR) in France and Germany, 11 urban areas without river restorations (no URR), and 46 urban areas without an entry.

2.2. Data Collection

The contact people recommending specific urban river restoration projects were contacted between 10 April 2013 and 10 November 2013. According to guidelines for river restoration survey, each contact person was directly called [13,38,39]. The competence of the contact person was previously checked by a preliminary short interview to assure in-depth political, administrative, and technical knowledge of the restoration project. Finally, interviewees were asked either (a) to fill out the questionnaire and to return it per email or per post; or (b) to arrange an interview by phone. Contact persons who agreed to fill the questionnaire received follow-up calls to encourage a response after two weeks. One researcher carried out the entire procedure to avoid operator bias. Interviewees received the filled form per mail to ensure proper reporting. The 75 project entries of the database resulted from 34 oral and 98 written responses.

2.3. Variables

The interview form (Form A1) was direct, structured, and composed of partly closed questions [40]; namely, few questions were asked, were formulated in the same order, and interviewees

mostly had to choose from a restricted list of answers. We used the same form for both oral and written procedures. To introduce the interview, the interviewee should be given a short description of the project (2–3 sentences) mentioning the project context and the restoration goals. Then the interview consisted of the following five groups of questions: What is the project title? When was the project implemented? What is the project motivation? What was the morphological status of the river before the project? Which measures have been implemented? The variables are listed in Table A2. The list of restoration measures and goals have been obtained by reviewing previous publications on river restoration surveys [11,13,38,41–43]. We gathered similar goals under broader labels as, for example, grouping channel reconfiguration, bank stabilization, dam removal, etc., under the goal "reestablishment of near-natural pattern of the river hydromorphology". We identified nine project goals: improvement of the flood protection potential, improvement of the water quality, restoration of the riparian habitats, restoration of the aquatics habitats, reestablishment of the near-natural pattern of the river hydromorphology, renewal of the city, enhancement of the recreational potential of the river, reestablishment of the longitudinal connectivity, and reduction of pressures caused by hydro power plants. We kept all of the mentioned measures. Since implemented measures could meet diverse goals, interviewees had to choose the purpose of the mentioned implemented measures. It should be also noted that the project motivation, namely the single main reason of existence of the project, differs from the restoration goals, which could be multiple. The project title and the short project description were translated into English.

We verified the answers about morphological status of the rivers against aerial photographs to ensure that the interviewees' responses reflected the actual state of the rivers. We found no differences. Since chemical status had been assessed for less than 50% of the E.U. rivers [35] and local sampling did not match with the studied areas, we ignored this variable.

2.4. Data Analyses

We applied a comparative analysis between projects in France and Germany to assess (dis) similarities between the projects combining statistical analyses using R [44] version 1.31.3 and textual analysis using IRaMuTeQ 0.7 alpha 2 supported by R [45], which is a qualitative lexical data analysis software developed by the research team LERASS from the Universities of Toulouse and of Montpellier, France. All analyses were considered significant at $p < 0.05$.

First, to investigate the difference of socio-cultural drivers of the restoration effort, such as the implementation of the WFD or the increasing recreational demands (hypothesis 1) we performed tests for equality of proportions on the variables project motivation (Figure 2), restoration goals, and the date of implementation (before or after 2000). Results were synthesized into Table 2. Furthermore, an analysis of word co-occurrences on project short descriptions informed more deeply about the restoration drivers.

Second, to investigate the different understanding of the restoration approach (hypothesis 2), we compared the frequencies of the term into the project titles. We also performed a comparison of frequencies of implemented measures for each restoration goal between (a) projects located in France or in Germany; and between (b) projects including or not the term restoration into their title. The results of this analysis are presented in Figure 3.

Third, to investigate the difference of antecedent conditions mirroring different historical relationships between citizens and urban rivers (hypothesis 3), we performed tests for equality of proportions between the countries on the variables related to the morphological status of the river prior to the implementation of the restoration, i.e., straightened channel, existence of highways along the riverbank, channelization, impervious embankments, impervious river beds, longitudinal connectivity damage, buried rivers, and navigable rivers. Results of this comparison are synthesized into Table 2. Furthermore, we performed an analysis of word co-occurrences on project short descriptions, excluding articles, conjunctions, and prepositions, and gathering similar words, e.g., restore and restoration. The words which did co-occur within statements indicate meaningful associations [46].

Table 2. Synthesis of the differences and similarities between urban river restorations in France and Germany.

Themes	River Restoration Characteristics that Are Specific to Germany (% of the projects in Germany)	River Restoration Characteristics that Are Specific to France (% of the projects in France)	River Restoration Characteristics Found in Similar Proportion in Both Countries (% of the project in both countries)
Project motivation	Implementation of the WFD (60%)	Improvement of the quality of life for citizens (55%)	Improvement of the flood protection management strategy (10%–20%), Other motivations (10%–20%)
Morphological status	Straightened channel (83%), existence of highways or national roads along the riverbanks (6%)	Straightened channel (60%), existence of highways or national roads along the riverbanks (50%)	Channelized (>87%), impervious embankment (>97%), impervious bed (66%), continuity damaged (55%–65%), buried (13%–16%), and navigable (20%–27%)
Project date			Restoration boom after 2000
Project title	Restoration (51.2%)	Reclamation (18.7%), restoration (12.5%), or rehabilitation (9.4%)	
Discourse	Used of word pair River/WFD	Used of word pair City-River, and importance of recreational goals	Mention of the WFD
Measures to improve the flood protection potential			Dyke removal, dyke renewal or construction, creation of shallow water area, creation of flood depression area, and increase retention potential of the floodplain
Measures to improve the water quality			Construction of water treatment plant, planting of green buffer area, treatment of rainwater, and removal of rainwater outlet
Measures to restore riparian habitats	Creation of Flooded areas (18%), and planting of vegetation succession (58%)	Creation of Flooded area (0%), and planting of vegetation succession (84%)	Creation of ponds, creation of wetlands, improvement of the vegetation mosaic, change of the management concept, riparian forest conversion, planting of riparian forest, extensive uses of the riparian area, species reintroduction, and invasive management
Measures to restore aquatic habitats	Deadwood management (15%), and improvement of the erosion or the sedimentation potential through morphological changes (25%)	Deadwood management (0%), and improvement of the erosion or the sedimentation potential through morphological changes (6%)	Riverbank flattening, creation of shallow water area inside the water course, creation of temporary water, improvement of the flow heterogeneity, improvement of the flood depression potential, and creation of spawning area
Measures to reestablish near-natural patterns of the river hydromorphology	Removal of artificial bank constructions (68%), and connection of sidearm or tributaries (5%)	Removal of artificial bank constructions (39%), and connection of sidearm or tributaries (32%)	Substrate excavation, river bed expansion, water course extension, river embankment modeling, meandering, reopening of tributaries, river bed raising, and creation of island
Measures to renew city planning	Improvement of the accessibility (30%), creation of shopping area (0%), creation of recreational area (15%), and city reconstruction (7%)	Improvement of the accessibility (87%), creation of shopping area (13%), creation of recreational area (65%), and city reconstruction (39%)	Creation of new connections, (e.g., bridge), road removal, creation of residential areas, creation of business parks, and creation of piers
Measures to enhance the recreational potential at the river	Creation of paths (65%), planting of recreational grassland (15%), creation of playground (22%), design park (35%), rehabilitation of towpath (32%), creation of watersport facilities (0%), and creation of recreational pier (0%)	Creation of paths (97%), planting of recreational grassland (52%), creation of playground (58%), design park (71%), rehabilitation of towpath (74%), creation of watersport facilities (19%), and creation of recreational pier (13%)	Creation of platforms, enable contact with nature, creation of fitness trails, creation of swimming facilities, and nature protection and conservation pedagogic opportunities
Measures to reestablish the longitudinal connectivity	Bed glide removal (35%), and creation of bypass channel (17%)	Bed glide removal (9%), and creation of bypass channel (0%)	Weir removal, creation of fish pass, slide removal, and creation of bed ramp
Measures to reduce pressures caused by hydropower plant			Increase residual water, decrease residual water, construction of hydropower plant, and removal of hydropower plant

3. Results

The investigation of the restoration driving force (hypothesis 1) showed major differences between the countries. French and German authorities restored their rivers with the same intensity (between 50% and 60% of the FURR and GURR). Most of the projects (>80%) in both countries were implemented after 2000, the date of signature of the WFD. However only 45% of the projects were initiated to implement the WFD. Differences between countries existed with regard to most variables and are summarized in Table 2. The most frequent project motivation in Germany was the implementation of the WFD (60%), while the desire for a better quality of life for the citizens was the most declared motivation in France (55%) (Figure 2). Accordingly, measures intending to improve the recreational potential and the integration of the river into the city are more often implemented in France than in Germany (Table 2), i.e., planting of recreational grassland (52% of the FURR against 15% of the GURR), creation of playgrounds (58% of the FURR against 22% of the GURR), improvement of the river accessibility for recreational users (87% of the FURR against 30% of the GURR). Before the WFD came into force, few projects had been implemented in both countries: $n = 5$ in France and $n = 8$ in Germany. However, already at this time, an important part of GURR were initiated to improve the ecological status of the rivers (50%), whereas this motivation was mentioned only once in France. Textual analysis on the project descriptions also showed that communications about projects in Germany referred more often to the term "restoration" and the WFD than communications about French projects (51.2% of GURR against 12.5% of FURR).

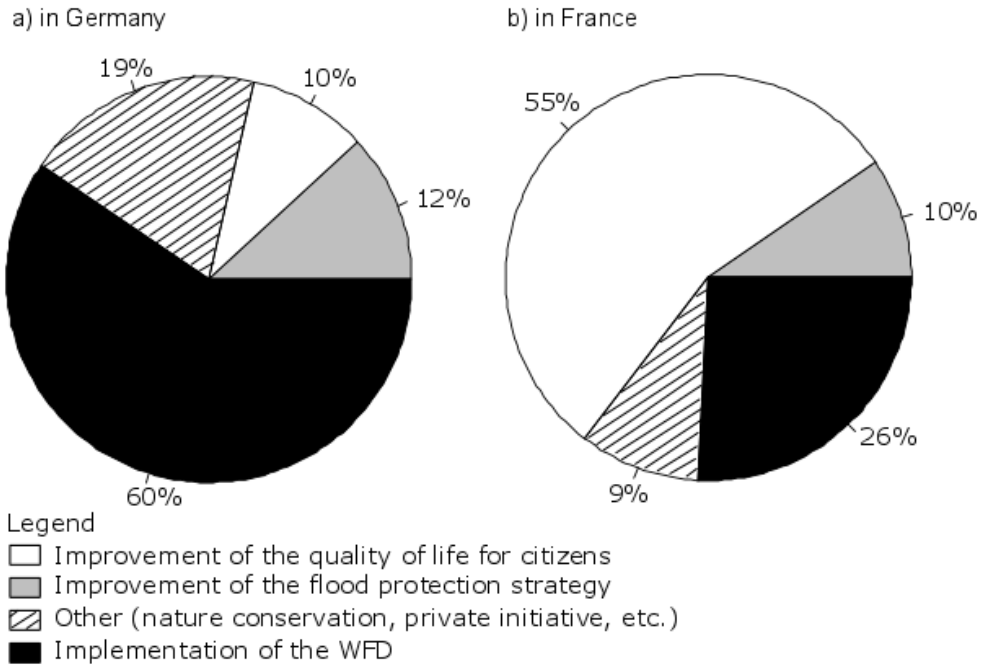

Figure 2. Pie chart of the main project motivations (**a**) in Germany, and (**b**) in France.

The comparison of the understanding of the restoration approach between the countries (hypothesis 2) showed that the French approach is broader than the German approach, which focuses on the ecological improvement according to the WFD. The comparison of the terms used in the project title showed that the word "restoration" was the most frequent in Germany (51.2% of the projects, $n = 22$) whereas, in France, the diversity of terms was higher, e.g., reclamation (18.7%, $n = 6$), restoration (12.5%, $n = 4$), and rehabilitation (9.4%, $n = 3$). The analysis of word co-occurrences on the short project descriptions showed that, in France, the relationship between the city (used for 46% of the projects) and the river (used for 75% of the projects) is meaningful with a co-occurrence for 32% of the projects,

whereas in Germany the terms WFD (used for 50% of the projects), restoration (used for 42% of the projects), and ecological (used for 35% of the projects) are the most frequent terms of the project descriptions and have a high degree of co-occurrence (46% of the projects). The investigation on the relationship between the project title and the implemented measures showed that: (a) in both countries, projects labelled "restoration" implemented similar measures and with similar frequency (Figure 3). For example, French and German projects labelled "restoration" intend to improve physical habitats by reestablishing (i) near-natural patterns of the river hydromorphology through artificial bank removal, embankment remodeling, and bed expansion; and (ii) the longitudinal connectivity through river bed glide removal and construction of fish friendly solution, such as ramps and fish passes; (b) the main differences between projects in France and Germany concerned projects with title other than "restoration", e.g., rehabilitation. French projects not labelled "restoration" significantly differed from French projects labelled "restoration" and German projects. The difference between the German projects labelled "restoration", or not, is less significant than in France. The differences concern ecological and social measures.

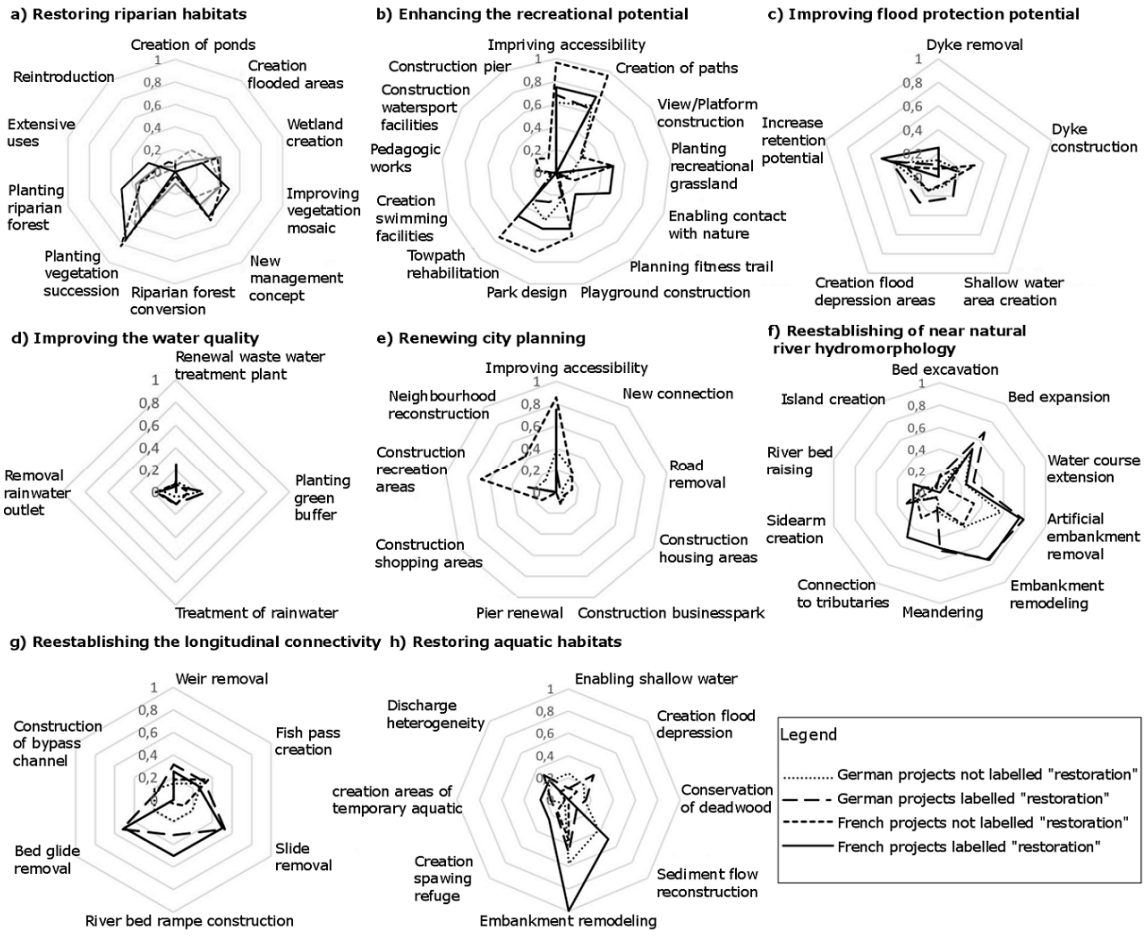

Figure 3. Frequency of implementation of the restoration measures regarding restoration goals, title of the project and the country where the project was implemented.

The investigation of different antecedent morphological conditions between the countries (hypothesis 3) was conclusive. The morphological pattern of the rivers prior to restoration differed with regard to two characteristics (Table 2): the straightened river channel and the existence of highways or national roads along the riverbanks. German rivers were straighter than French rivers (83% of the restored urban river sections in Germany against 60% in France) and highways more often bordered restored river sections in France (50%) than in Germany (6%). Removal of roads at the riverside as

part of URR was not significantly more frequent in France than in Germany. The analysis of the short project descriptions showed that the relationship between citizens and their rivers is an issue in France (46%), but not in Germany.

4. Discussion

The objectives of this study were to provide a detailed account of the French and German urban river restoration efforts, comparing projects in both countries and focusing on their political and socio-cultural drivers. Our results showed that: (a) in both countries, the urban river restoration effort is partly driven by EU policy, but with different intensity; (b) the understanding of the restoration approach in both countries is similar, but differs for projects that are not labelled as restoration; and (c) historical relations between citizens and their rivers highly influence the restoration strategy and consequently practices.

The WFD is one of the most ambitious environmental EU policies and is a driver of the European restoration effort and river governance [12]. The WFD intends to homogenize the EU water policy and demands to protect and/or restore all EU water bodies. France and Germany qualified the demands of the WFD as obligations of results [47]. However, the study showed that the influence of the WFD on the restoration practices is limited. In particular, in France, where only a quarter of the URR has been directly motivated by the implementation of the WFD, the improvement of the quality of life for citizens was the most frequent project motivation. This finding shows a disconnection between macro-level policy and micro-level governance and practice. However, despite the fact that Aradóttir [11] stated in the case of Iceland, that policies have limited impact on restoration practices and governance, the WFD seems to be a great value to set ecological standards of the European restoration effort. The study showed that, despite this common framework, both countries developed different URR practices and approaches underscoring the strength of micro-level societal drivers. German URR is ecologically oriented, as defined by the WFD, which places aquatic ecology in the center of river restoration [12]. In France, the restoration approach is understood more broadly and projects were both ecologically and societally oriented. The differences between the countries may have several socio-cultural reasons and indicate the importance of national contexts.

First, according to a Europa-wide comparative study of landscape planning policies and landscape approaches [28], our results showed that the German urban river restoration approach focuses more on ecological improvement than French projects, which are more comprehensive. Germany is, historically, an industrialized country with high population density [26] and related pollution problems. The Sandoz Industry disaster (1986) causing major pollution of the Rhine River initiated in Europe, and more particularly in Germany, changes of environmental perception and governance strengthening policy for nature conservation and (river) restoration [48]. According to this background, the German ecological river restoration trend was initiated long before the WFD came into force, for instance, with the emblematic Project Emscher restoration (1992–2020) [49,50]. This circumstance may explain why German water governance is particularly related to an ecological approach similar to the one formulated by the WFD. This finding underscores the difficulties of changing water governance trends as also described in the Philippines [51].

Second, previous study showed that recreational demands are, since the 1990s, increasingly important motivations of restoration [11]. Citizens value the benefits of urban green spaces according to various subjective parameters, such as their perception of the area [29]. However, a comparative study between France and Germany showed that nature perceptions of city-dwellers differ between both countries in their preference for nature-control, namely, that it is higher in France than in Germany [30]. As expected from this background we found that French URR implemented measures quite well for the improvement of the recreational potential via man-made recreational facilities (e.g., playgrounds) in comparison with German URR. On the contrary, measures, such as the keeping of deadwood, at the river banks could not be observed in France, probably because it did not fit with the perception of a well-kept urban landscape. We assume that, in the context of socio-ecological

change perceptions of nature, may evolve apace and that educational work should guide perception changes, ensuring public support to ecologically-oriented projects.

Third, urban-crossing rivers have social values beyond the ecological [52]. The emotional and spiritual relationship between human beings and the rivers impact the governance and drivers of river conservation and restoration [9] . We suggest that the historical relation between citizens and their rivers influenced the project motivation and related implemented social measures. This can be evidenced by the morphological development of the river. We found that French and German urban rivers had similar morphological status prior to restoration. The single significant difference between the restored urban river sections in these countries was the more frequent existence of urban express road or highways on the riverbanks in France. Urban highways have been built in Europe, as in post Second World War North America, during the auto city trend using vacant plot of land [53]. German urban riversides are relatively free from urban highways, in comparison with France, even if exceptions exist. While the French state owned the major part of the urban riverside that offers a convenient plot of land for the urban highway construction [54], neglecting social and ecological values of the river, construction of most of the German major cities infrastructure benefited from the tabula rasa caused by U.S. bombing during the Second World War, offering vacant plots of land [55]. Interestingly, the four German URR of our sample bordering an urban highway, i.e., Saarbrücken, Siegen, Darmstadt, and Frankfurt am Main, are outliers of the German trend and have been initiated to improve the quality of life for citizens, much like most of the French URR. The finding suggests that the existence of highways on the riverside strongly influences the ecological and social restoration potential. However, we found that highways have not been removed during the restoration process. This is understandable considering that the URR stakeholders are mainly local or regional, whereas the highway removal can only be decided by national authorities.

Our study presents an original dataset of URR, a group of river restoration projects previously underrepresented in national, as well as European databases, and in publications. The extensive survey and the high participation rate led to a high significance of our results. However, we cannot definitively affirm that studied societal drivers, i.e., political and socio-cultural, alone accounted for country specific restoration trends. Other drivers or other unknown variables may also have contributed to this effect. Finally, according to the goals of the study, we presented an overview of the trends. Exceptions exist in the dataset.

5. Conclusions

This study explored the influence of some societal drivers, i.e., political and socio-cultural, on the urban river restoration trends in France and Germany. We found that the WFD assures an ecological standard and the same understanding of river restoration in Europe, but drives with more intensity urban river restoration efforts in Germany than in France. The study showed that micro-level drivers still overtake E.U. policy. The differences of practices between the countries may have several socio-cultural reasons and indicate the importance of considering national and local contexts to avoid disconnection between policy, practices, and governance.

First, our results highlighted the historical ecologically-oriented water governance in Germany. However, even if the French urban river restoration effort is more often motivated by the improvement of the quality of life for citizens than by the implementation of the WFD, ecological improvements are still a major concern.

Second, national urban river restoration trends mirror different relationships between humans and nature. Understanding the implications of city dwellers' perceptions and expectations for urban open space planning is an important issue to estimate public endorsement, orchestrate public participation, support educational work, and ensure coherence in the water governance strategy.

Third, previous water governance strategies indirectly, but strongly, drive the current river restoration effort. Reversing historical morphological changes and restoring social and ecological functions need cooperation between stakeholders working in different agencies and government.

Taken together, our findings demonstrated that, despite powerful European legislation, the urban river restoration efforts still maintain strong national specificities. The study demonstrates that socio-cultural differences challenge the unity of E.U. water governance. Despite common requirements for ecological quality of the freshwater bodies within the European Union, the variation of societal driving forces and other contextual conditions would make it difficult if not impossible to develop a "silver bullet" approach for urban river restoration. However, a comparison of projects based on rigorous analytical frameworks, as initiated with this study, is helpful for supporting further development of guidelines for urban river restorations.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. List of the surveyed urban areas with, first, those with urban river restoration project(s); second, those without urban river restoration projects; and, third, those that did not answer the survey.

	City Name	Country	Project Title (Original Language)
Cities with URR			
1	Recklinghausen	Germany	Wiederherstellung der Durchgaengigkeit des Baerenbachs
2	Annemasse	France	Contrat rivière
3	Limoges	France	Contrat rivière
4	Angers	France	Rives Nouvelles
5	Augsburg	Germany	Wertach Vital
6	Bottrop	Germany	Emscher Zukunft
7	Chambéry	France	Confluence Leysse et Hyeres
8	Frankfurt am Main	Germany	Main 2015
9	Hamm	Germany	Lippeaue
10	Lyon	France	Berges du Rhône
11	Montpellier	France	Lez Vert
12	Munich	Germany	Neues Leben fuer die Isar
13	Neuss	Germany	Pilotprojekt Gnadenthal
14	Nice	France	Coulee verte
15	Reims	France	Trame verte
16	Rennes	France	Prairies Saint-Martin
17	Saarbruecken	Germany	Stadtmitte am Fluss
18	Siegen	Germany	Siegen zu neuen Ufern
19	Caen	France	Parc periurbain Orne Odon
20	Duisburg	Germany	Rhein Park in Duisburg
21	Ingolstadt	Germany	Stadt Park Donau
22	Offenbach am Main	Germany	Mainuferpark
23	Pau	France	Parc naturel urbain du Gave de Pau
24	Toulouse	France	Parc Garonne
25	Bordeaux	France	Plan Garonne
26	Le Mans	France	Programme de lutte contre les inondations
27	Besançon	France	Amenagement des bords du Doubs
28	Cottbus	Germany	Umgestaltung der Spree
29	Fürth	Germany	Neugestaltung der Gewaesser Talraum in Pegnitz
30	Halle	Germany	Umgestaltung der Saale
31	Hannover	Germany	Umgestaltung der Ihme
32	Kiel	Germany	Naturnahe Umgestaltung des Gewaessersystems Hasseldieksau und Struckdieksau
33	Krefeld	Germany	Deichsanierung an der Rhein
34	Leverkusen	Germany	Naturnahe Umgestaltung der Dhuenn
35	Marseille	France	Réamenagement de l'Huveaune
36	Nancy	France	Aménagement de la rivière Meurthe
37	Perpignan	France	Réamenagement de la Têt
38	Poitiers	France	Aménagement des berges du Clain
39	Valence	France	Aménagement des canaux
40	Annecy	France	Requalification du Fier
41	Calais	France	Revalorisation des canaux et berges

Table A1. *Cont.*

	City Name	Country	Project Title (Original Language)
Cities with URR			
42	Orléans	France	Requalification de la rive Sud
43	Metz	France	Renaturation de la Seille
44	Thionville	France	Renaturation des berges de Moselle
45	Darmstadt	Germany	Offenlegung des Darmbachs
46	Grenoble	France	Reouverture du Verderet
47	Leipzig	Germany	Offenlegung der Pleisse und des Elstermuehlgrabens
48	Paris	France	Réouverture de la Bièvre
49	Saint-Etienne	France	Réouverture du Furan
50	Aachen	Germany	Renaturierung der Wurm
51	Berlin	Germany	Renaturierung der Panke
52	Bochum	Germany	Renaturierung der Emscher
53	Bremen	Germany	Renaturierung Weserufer
54	Brest	France	Restauration de la Penfeld
55	Clermont-Ferrand	France	Restauration de la Tiretaine
56	Dijon	France	Restauration de continuité écologique au Lac du Tir
57	Goettingen	Germany	Renaturierung der Leine
58	Herne	Germany	Renaturierung der Emscher
59	Hildesheim	Germany	Renaturierung Grabens
60	Karlsruhe	Germany	Renaturierung der Alb
61	Kassel	Germany	Renaturierung Ahna
62	Köln	Germany	Renaturierung des Flehbachs
63	Ludwigshafen am Rhein	Germany	Renaturierung des Altrheingrabens Isenach Moerschbachs
64	Moenchengladbach	Germany	Renaturierung des Bungtbachs
65	Moers	Germany	renaturierung der Moersbach
66	Muenster	Germany	Renaturierung der munstersche Aa
67	Nurenberg	Germany	Renaturierung der Pegnitz
68	Paderborn	Germany	Renaturierung der Pader
69	Pforzheim	Germany	Renaturierung der Enz Wurm Nagold
70	Potsdam	Germany	Renaturierung Nuthe
71	Rostock	Germany	Renaturierung des Carbaek
72	Strasbourg	France	Restauration du Muhlbach de Koenigshoffen
73	Stuttgart	Germany	Renaturierung der Nektar
74	Wolfsburg	Germany	Renaturierung Allerniederung der Kästorf bei Warmenau
75	Wuppertal	Germany	Renaturierung der Wupper
Cities without URR			
76	Angoulême	France	
77	Bayonne	France	
78	Béthune	France	
79	La Rochelle	France	
80	Lorient	France	
81	Montbéliard	France	
82	Nîmes	France	
83	Rouen	France	
84	Toulon	France	
85	Valenciennes	France	
86	Magdeburg	Germany	
Cities without answer			
87	Amiens	France	
88	Avignon	France	
89	Creil	France	
90	Dunkerque	France	
91	Le Havre	France	
92	Lille	France	
93	Mulhouse	France	
94	Nantes	France	
95	Saint-Nazaire	France	
96	Tours	France	
97	Troyes	France	
98	Bergisch Gladbach	Germany	
99	Bielefeld	Germany	
100	Bonn	Germany	
101	Braunschweig	Germany	
102	Chemnitz	Germany	
103	Dortmund	Germany	
104	Dresden	Germany	
105	Düsseldorf	Germany	
106	Erfurt	Germany	
107	Erlangen	Germany	
108	Essen	Germany	
109	Freiburg im Breisgau	Germany	
110	Gelsenkirchen	Germany	
111	Hagen	Germany	
112	Hamburg	Germany	
113	Heidelberg	Germany	
114	Heilbronn	Germany	
115	Jena	Germany	
116	Koblenz	Germany	
117	Lübeck	Germany	
118	Mainz	Germany	
119	Mannheim	Germany	
120	Mülheim an der Ruhr	Germany	
121	Oberhausen	Germany	
122	Oldenburg	Germany	
123	Osnabrück	Germany	

Table A1. *Cont.*

	City Name	Country	Project Title (Original Language)
Cities without answer			
124	Regensburg	Germany	
125	Remscheid	Germany	
126	Reutlingen	Germany	
127	Salzgitter	Germany	
128	Solingen	Germany	
129	Trier	Germany	
130	Ulm	Germany	
131	Wiesbaden	Germany	
132	Würzburg	Germany	

Form A1. Interview form.

City:

. . . . . .

. . . . . .

1) Project

Did river(s) inside the city territory have been restored since 1980?

☐ Yes
☐ No

What is the project title? . . . . . .

Could you please shortly describe the project mentioning context elements and main goals?

. . . . . .

. . . . . .

. . . . . .

. . . . . .

2) Status

How was the morphological status of the river/stream before the project?

☐ Channelized river course
☐ Straightened channel
☐ Impervious riverbank
☐ Artificial river bed
☐ Longitudinal connectivity damaged
☐ Existence of national road or Highway at the river side
☐ Buried river

Is the river navigable?

☐ yes
☐ no

3) project motivation

What is the project motivation (single answer)?

☐ Implementation of the WFD
☐ Ecological (ante signature of the WFD), e.g., Reestablishment of the migration potential for fish, Nature conservation (Natura 2000), Restoration of (sensitive) habitats
☐ Improvement of the flood protection strategy
☐ Improvement of the quality of life for citizens
☐ Other . . . .

4) project cost and funds

How expensive was the project (€):
. . . . . .
. . . .

Which institution or program financed the project?

☐ European Union

If yes, which program? . . . .
If yes, which percent of financing? . . . . . .

☐ State and Water Agency

If yes, which percent of financing? . . . . . .

☐ City government

If yes, which percent of financing? . . . . . .

☐ NGO

If yes, which percent of financing? . . . . . .

5) Restoration measures

Which measures have been implemented to:

a) improve the flood protection potential

☐ Dyke removal
☐ Dyke renewal or construction
☐ Creation of shallow water area
☐ Creation of flood depression area
☐ Increase retention potential of the floodplain

b) to improve the water quality

☐ Construction of water treatment plant
☐ Planting of green buffer area
☐ Treatment of rainwater
☐ Removal of rainwater outlet

c) to restore riparian habitats

- ☐ Creation of ponds
- ☐ Flooded area
- ☐ Creation of wetland
- ☐ Improvement of the vegetation mosaic
- ☐ Change of the management concept
- ☐ Riparian forest conversion
- ☐ Planting of vegetation succession
- ☐ Planting of riparian forest
- ☐ Extensive uses of the riparian area
- ☐ Species reintroduction

d) to restore aquatic habitats

- ☐ Deadwood management
- ☐ Improve the erosion or the sedimentation potential through morphological changes
- ☐ Riverbank flattening
- ☐ Creation of shallow water area inside the water course
- ☐ Creation of temporary water
- ☐ Improvement of the flow heterogeneity
- ☐ Improvement of the flood depression potential
- ☐ Creation of spawning area

e) to reestablish near-natural patterns of the river hydromorphology

- ☐ Substrate excavation
- ☐ River bed expansion
- ☐ Water course extension
- ☐ Removal of artificial bank constructions
- ☐ River bank flattening
- ☐ Meandering
- ☐ Connection of sidearm or tributaries
- ☐ Reopening of tributaries
- ☐ River bed raising
- ☐ Creation of island

f) to renew the city planning

- ☐ Improvement of the accessibility
- ☐ Creation of new connection, e.g. bridge
- ☐ Road removal
- ☐ Creation of residential area
- ☐ Creation of business park
- ☐ Creation of pier
- ☐ Creation of shopping area
- ☐ Creation of recreational area
- ☐ City reconstruction

g) to enhance the recreational potential at the river

- ☐ Improve accessibility
- ☐ Creation of paths
- ☐ Creation of platform
- ☐ Planting of recreational grassland
- ☐ Enable contact with nature
- ☐ Creation of fitness trail
- ☐ Creation of playground
- ☐ Design park
- ☐ Rehabilitation of towpath
- ☐ Creation of swimming facilities
- ☐ Nature protection and conservation pedagogic opportunities
- ☐ Creation of watersport facilities
- ☐ Creation of recreational pier

h) to reestablish the longitudinal connectivity

- ☐ Weir removal
- ☐ Creation of fish pass
- ☐ Slide removal
- ☐ Creation of bed ramp
- ☐ Bed glide removal
- ☐ Creation of bypass channel

i) to reduce pressures caused by hydropower plant

- ☐ Increase residual water
- ☐ Decrease residual water
- ☐ Construction of hydropower plant
- ☐ Removal of hydropower plant

Table A2. Variables of the database and their possible entries.

Variables	Sub Variables	Entries
Project		Implementation of the WFD
Motivation		Ecological but not WFD related (prior WFD, nature conservation, Natura 2000, agenda 21, etc.)
		Improvement of the flood protection strategy
		Improvement of the quality of life for citizens
		Other
Morphological status	Channelized river course	Yes/No
	Straightened channel	Yes/No
	Impervious riverbank	Yes/No
	Artificial river bed	Yes/No
	Longitudinal connectivity (for fish migration) damaged	Yes/No
	Existence of national road or highway at the river side	Yes/No
	Buried river	Yes/No
	Navigable	Yes/No

Table A2. *Cont.*

Variables	Sub Variables	Entries
Implemented measures	to improve the flood protection potential	listed in Form A1 and Figure 3
	to improve the water quality	
	to restore riparian habitats	
	to restore aquatic habitats	
	to reestablish near-natural patterns of the river hydromorphology	
	to renew city planning	
	to enhance the recreational potential at the river	
	to reestablish the longitudinal connectivity	
	to reduce pressures caused by hydropower	
Public participation		Yes/No
Project implementation		Before 2000 After 2000
Short project description		Qualitative variable (text)
Project label		Qualitative variable (text), e.g., restoration of the Aa in Münster

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