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**Research Master Planning and Sustainability: Urban and
Regional Planning**

**Governance and the societal drivers for the
restoration of rivers in Brazil**



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“The river that everything drags is known as violent, but nobody calls violent the margins that arrest him.”

- *Bertolt Brecht*

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List of Abbreviations

ANA	<i>Agência Nacional de Águas</i> (National Water Agency)
APP	<i>Area de Preservação Permanente</i> (Permanent Preservation Area)
BR	Brazil
CONAMA	<i>Conselho Nacional de Meio Ambiente</i> (National Environment Council)
ES	Ecosystem Services
EU	European Union
FES	Final Ecosystem Services
IBGE	<i>Instituto Brasileiro de Geografia e Estatística</i> (Brazilian Institute of Geography and Statistics)
IES	Intermediate Ecosystem Services
OECD	The Organisation for Economic Co-operation and Development
RBMP	River basin management plan
WFD	Water Framework Directive

1. Introduction

The use of rivers, streams and other natural resources were and are essential for the development of human kind whether about economic growth, health, security or culture. Rivers can provide food, energy, transportation, leisure, wellbeing and wealth as long as they are preserved, their water quality and environment kept healthy. All those benefits provided from the rivers are part of the ecosystem services that humans freely gain from the natural environment and from properly-functioning ecosystems. According to Millennium Ecosystem Assessment Organization (2005), ecosystem services can be grouped in four categories, namely: *provisioning*, such as the production of food and water; *regulating*, such as the control of climate and disease; *supporting*, such as nutrient cycles and crop pollination; and *cultural*, such as recreational benefits.

Placing these categories only for the situation of rivers and streams, we are able to give the following examples (Millennium Ecosystem Assessment 2005; Arthington et al. 2010; Everard & Moggridge 2012; Scott Shafer et al. 2013; Vollmer & Grêt-Regamey 2013; Vermaat et al. 2016):

- **Provisioning services:** Riverine areas provide many goods for humans. For example, rivers and streams supply freshwater, hydraulic energy, food, gravel, biodiversity and the riparian zone make available, among others, a wide diversity of wood products.
- **Regulating services:** Rivers and their floodplains perform processes maintaining the world in which it is biophysically possible for humans to live, e.g. climate stabilization, nutrient sequestration, water purification, and mitigation of flood damages.
- **Cultural services:** Rivers make the world a place in which people want to live, offering for example recreation possibilities, aesthetic, intellectual, and spiritual inspirations.
- **Supporting services:** Riverine ecosystem processes are of major importance among for nutrient cycling, landscape formation, and creation of habitats.

All these services are named and fundamentally important, but even though rivers in many countries face strong impacts from human activity, in cities as in rural areas, receiving thousands of tons of sewage, diffuse pollution, diverse solid waste, pesticides and animal waste (in case of rural areas) – besides the extreme morphological modification of rectification and waterproofing of its banks. That is the case of many Brazilian rivers and streams. As an answer to the often unpleasant or even dangerous nature of these rivers, earlier Brazilian policies treated them with neglect, which frequently

resulted in active separation of areas with human activities and rivers by channeling them with study materials (UMFG, 2018) or even by covering them completely with concrete. In the mentality of Brazilian urbanites, this process is seen as a necessary step towards progress, by fostering economic activities, reducing sanitary risks, and improving the aesthetic aspect of an area (Macedo and Magalhães Junior 2011 apud. Wantzen et al. unpublished). For many years, rivers did not receive any attention either from politics or the population. Only after the United Nations Conference on Environment and Development in 1992, which took place in Rio de Janeiro, Brazil began to plan and implement restoration projects. In summary, the success so far is rather little, which is partly due to a strong focus on interests of the political elite, which aimed to the modernisation and economic improvement of the city but not to the requirements of the population and healthy river ecosystems. This can be seen as a result of the “hereditary captaincy” (Lisboa, 2008, p. 22) system which granted governors the right to rule developments by their own interests. While the political system has formally changed, the same mentality remains among the political elite who descend from the very same families. However, current science agrees on the necessity for participation of numerous stakeholders including the public in order to achieve sustainable decisions and developments, which is called governance.

According with Dernbach (1998, apud Emas, 2015) “effective governance requires a nation to consider and protect the environment and natural resources on which its current and future development depend. Any other approach is self-defeating. The connections between the environment and development thus provide a powerful rationale for environmental protection: enlightened self-interest”. Even so, a weak environmental governance led Brazilian rivers and streams to highly degraded conditions, which also is observed in other countries of the Global South. Yet it is known that there are efforts, punctual and increasing, to reverse this situation. Unfortunately, they are not well publicized and/or structured resulting in low probability of success, replication or improvements. It is necessary to reverse this scenario. However, firstly it is mandatory to bring up the main causes of Brazil’s governance problems that result in deficiencies of river restoration:

- **The political problem:** river restoration is rarely seen on the political agenda of Governors in Brazil and the budget for it is low (Costa, 2010, p.14) since other tasks are considered more urgent. Furthermore, the period of office lasts four years, after which the administration structure is regularly transformed. As restoration projects take longer than four years, it is extremely difficult to maintain them when staff is completely exchanged;

- **The law enforcement problem:** although Brazil has the largest and complete environmental law among other countries (including European Union and United States) the application of these laws is not effective, either for lack of supervision or, again, for the system of corruption housed in the most diverse levels of organization;
- **The education problem:** the deficiency in the quality of basic education in Brazil makes it difficult to understand the problem for the greater part of the population, including people with higher education.
- **The awareness problem:** people grew up without knowledge about the ideal status of rivers and have little knowledge about their potential benefits. Thus, the willingness to invest into restoration is little (Costa, 2010, p.14).
- **The resolution problem:** the challenge of proposing a new point of view on water resources in the country and, especially, to convince its uninstructed population, their importance and how (and why) they should be more participatory in the charging of durable solutions by the government. Commitment of the population is undoubtedly the key to the solution - not only of the environmental problems and of the remaining rivers in Brazil.

The problems of politics and education are deeply rooted in the Brazilian nation and its society, so a solution for them cannot be given at this point as changes in the methods of environmental policy will not be able to change them. Consequently, the focus of attempts for improvements should be firstly on the awareness and resolution problems in order to contribute to broader public knowledge about the benefits of river restoration. Since governance and public participation in planning processes are increasingly being seen as key factors for successful river restoration, the possibilities to introduce these factors into the Brazilian system of environmental policies must be identified.

The European Union can be considered as a leading example for widespread implementation of governance and participative planning models. The introduction of the Water Framework Directive in 2000 marked the beginning of a switch in all the member nations towards sustainable management and restoration of water bodies. It aims to understand and integrate all aspects of the water environment to be effective and sustainable (Voulvoulis et al., 2017, p. 359), in order to reach “good status” objectives for water bodies. Within different cycles of six years, the objectives were supposed to be achieved by 2015. For several reasons, the objectives were widely not met and extensions of the deadlines had to be set.

However, the implementation of the Water Framework Directive included a highly valuable transformation of policy practice: previously, the water policy of most member states could be characterised as top-down approaches, run by a number of different disciplines within administrative systems that acted independently to meet water quality objectives, such as the limitation of certain pollutant discharges. While this practice used to be efficient enough to keep a certain quality of the water and to prevent the most serious health-threatening environment impacts (ibid.), “it failed to consider the complexity of ecosystems or the interactions and trade-offs at different scales” (Müller-Grabherr et al., 2014 apud. Voulvoulis et al. 2017, p. 359). The reason for this failure is that the different disciplines were not working together and not sharing their knowledge, so that integrated policies could not be created. Currently, the Water Framework Directive is enforcing a shift from the fragmented policies of different disciplines towards governance-based approaches, which aim to merge all available knowledge by including a broad spectrum of stakeholders up to the civil public, in order to create management and restoration plans for the entire basins of the European rivers. The inclusion of the population in such large planning projects is an unprecedented process, and even if the EU is a coalition of nations and therefore not quite comparable with the Brazilian state, this approach is expected by the author to provide important information about solutions that might be modified and transferred to Brazil. Furthermore, the condition under which successful projects have taken place in the EU show which shortcomings in Brazil should be primarily addressed. Information about failures within the Water Framework Directive might additionally prevent misguided attempts for improvement.

Even though the necessity for public participation and certain other components of governance are well known in Brazilian politics, their implementation remains rather theoretical. Information and consultation of citizens with regard to issues of the common good water are mentioned at several points in environmental legislation, as the research in this paper will show. However, evidence of cases where citizens provided a noteworthy contribution to river restoration is scarce. Even during the largest ‘flag ship’ restoration projects, public participation has seemed to be merely a side aspect of the process in reality, even if the information material that is publicly available indicates high priority of broad governance approaches (Camargo, 2010).

During this research, it was possible to observe in case studies of both Brazil and the EU that a restoration project takes, on average, between five and 25 years to complete, with several but not very different objectives (such as climate change, protection against floods, promotion of recreational use of waters and even for the simple aesthetic improvement of the city). Even with different goals, the trigger for these projects to go out

of print and be successfully completed was, for the most part, one: the engagement of the population to pressure the governments of their municipalities, states and regions to take action for the restoration of rivers and effective water resources management – that is, those populations understanding for components of a healthy environment, such as clean air and water, are considered public goods as they are non-rival and non-excludable (Emas, 2015).

The reasons for the frequent shortcomings in public participation are diverse: Costa et al. (2010, p.16) name the problem that many projects in Brazil are carried out with purely environmental goals while neglecting the cultural ecosystem services that could be achieved. Consequently, there is only little public interest in those projects and indifference towards the outcome of the measures prevails when the public benefits are unknown. This means that even if participation is offered by authorities, the audience will be small. Again, small audiences reduce the willingness of the authorities to maintain participation in further projects. Therefore, the risk of further mental divergence between the population and the rivers cannot be ignored, as a lack of public interest also means that high budgets for restoration are not justifiable when it is not part of the political agenda.

Thus, in this work, the hypothesis is proposed that the engagement of the population is an inherent factor to the beneficial changes in the structure of governance (institutional changes) and management of water resources and that, through the study of successful European projects and policies where governance is working, important measures for a change of mentality in the Brazilian population can be deduced.

In order to approach this hypothesis, it is vital to fully understand the problems that governance in Brazil is facing with regard to public participation, to identify possible weaknesses in environmental legislation that serves to prepare water governance, to compare the overall situation of restoration in both the EU and in Brazil and ultimately to identify feasible solutions that will increase public interest in the restoration of healthy rivers.

The following questions will guide the research:

1. Which are the shortcomings in Brazilian environmental legislative with regard to governance in river restoration and which improvements can be derived from the EU Water Framework Directive?
2. How do governance and public participation contribute to the success of river restoration projects in Europe?
3. What are the reasons for the shortcomings of governance and public participation in Brazil and how can European examples improve the situation?

The research is structured in a way that allows to compare the situation of the EU and Brazil while respecting that the respective issues require individual research methods. After the most important terms and definitions are provided and the methodology is explained, the chapter on the research results presents the findings of the different research approaches that were conducted. This chapter is split into two parts (Brazil and the EU), which each deal with the same topics but focus on the local particularities, so that the two cases can be compared without losing sight of the key findings. The discussion of the results will aim to combine all the findings and thereby it will explain Brazil's current issues and provide solutions based on the European example.

2. Methodology

2.1. Research design

The thesis begins with definitions and explanations of the most important concepts in river restoration that will be used in later chapters. These are the concepts of ecosystem services, river restoration and governance. The information used for this is obtained from current literature as explained in 2.2.

After this literature-based approach, the situations of Brazil and the European Union regarding river restoration will be compared on different levels. Firstly, the most important laws that set the framework for restoration activities will be presented. By analyzing the differences, it will be shown to which extent Brazil might have unsuitable pre-conditions for governance and restoration. Following the comparison of the laws, a broader comparison of restoration in the two areas will be made. This aims to identify differences in the natural situations, restoration practices, governance and the important role of public involvement. In order to understand the significant shortcomings of public awareness and involvement in Brazilian governance, a public survey will be conducted. The situation of the EU will be described by findings of peer-reviewed literature and complemented by a comparative analysis of several successful river restoration case studies. The idea is to try to understand how the government (and the population) of these countries perceive and value their water courses and how this valuation may contribute to the success of restoration.

In the discussion chapter, the possibilities to replicate the success of European case studies in Brazil will be elaborated by focusing on the most important differences in current challenges and the resources to tackle them.

The conclusions will ultimately provide an overview on the findings and create a perspective for the future of Brazil's rivers.

2.2. Research methods

To give scientific background to this study, the research work was divided into four concomitant and complementary stages: literature review, population survey and the use of statistical methods to the analysis of these surveys as well as case studies to illustrate and confirm the findings of the literature research.

2.2.1. Literature review

In order to conduct the literature review, sources had to be selected depending on where the respective topic is placed scientifically and geographically. The concept of ecosystem services is a rather recent concept as the term emerged only in 2005 as a

result of the Millenium Ecosystem Assessment (Cerqueira, 2015, p. 48). The embedding and operationalization of the term is currently taking place. Therefore, recent peer-reviewed articles, mainly found in the ScienceDirect database, had to be consulted to obtain the current state of the art. Significant contributions to the term mainly stem from central Europe and the UK.

River restoration, however, has been conducted for several decades and unlike the Ecosystem Services Concept, its origins cannot be allocated to a certain region of the earth. Therefore, scientific sources are more diverse. Books and articles cited for the elaboration and definition of the term could be found globally and dates of issue varied strongly.

The concept of governance is also a rather recent term, as government practices and legislation internationally didn't use for forms of leadership besides top-down structures. The books that were cited to describe the term stem from the American continent, specifically, sources from Brazil were also consulted to obtain insight into the particular situation.

2.2.2. Surveys

Interviews were conducted for the general public of Brazil.

The questionnaire for the general public, which is understood here as not-organized civil society, has been drawn up in the simplest and clearest possible way so that people of all levels of education would be able to understand and answer the questions about the perception of these people in relation to the watercourses - and, why not, to make them go through a small reflection on the subject, even if quick.

This questionnaire (conducted through a Google online service) was disseminated through electronic means in social networks, university study groups, residential condominiums and private sharing of the people who answered the questionnaire.

The questionnaire named "Population Perception of Urban Watercourses" was designed in order to better understand the population's perception of the bodies of water around the localities where they live, in a way that the analysis of the answers could support the understanding of the degree of knowledge of the population and whether this knowledge (or lack thereof) is linked to the place of residence, education level, gender, age and / or family income. This questionnaire, formulated with 27 questions listed below, has been prepared in Portuguese and uses simple and non-technical vocabulary to enable people of varying levels of education (including older and general, the level of education is lower) could answer it without major problems.

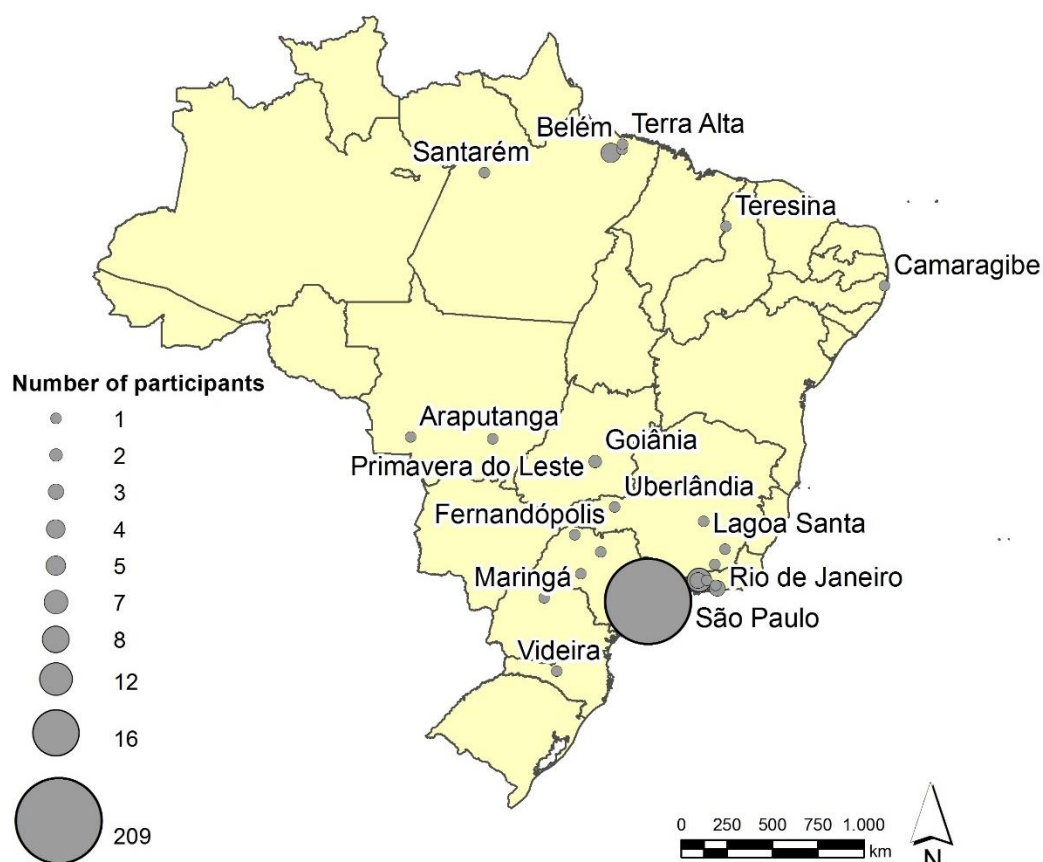
Even so, it was realized that even people with complete higher education had some difficulty understanding some terms like "watercourse", which from this point demonstrates the deficiency of basic education in the country.

When talking about river restoration it is possible to spend lots of time deliberating about engineering technologies, funding, research and other criteria but usually none of them will be put into practice unless people who are involved are truly aware of the real situation and its impacts. Hence, one of the research questions for this work was how European societies perceived and value their water bodies such as rivers and streams and how this perception led them to succeed in river restoration projects.

So, it was necessary to understand, through online research, how the Brazilian population sees its rivers and streams and how important they are attributed - only an aware population can charge its rulers with effective and lasting solutions.

As shown in the following map, 351 responses were obtained, distributed in 11 states and 54 cities, with greater participation in cities in the Southeast of the country, more specifically in the city of São Paulo.

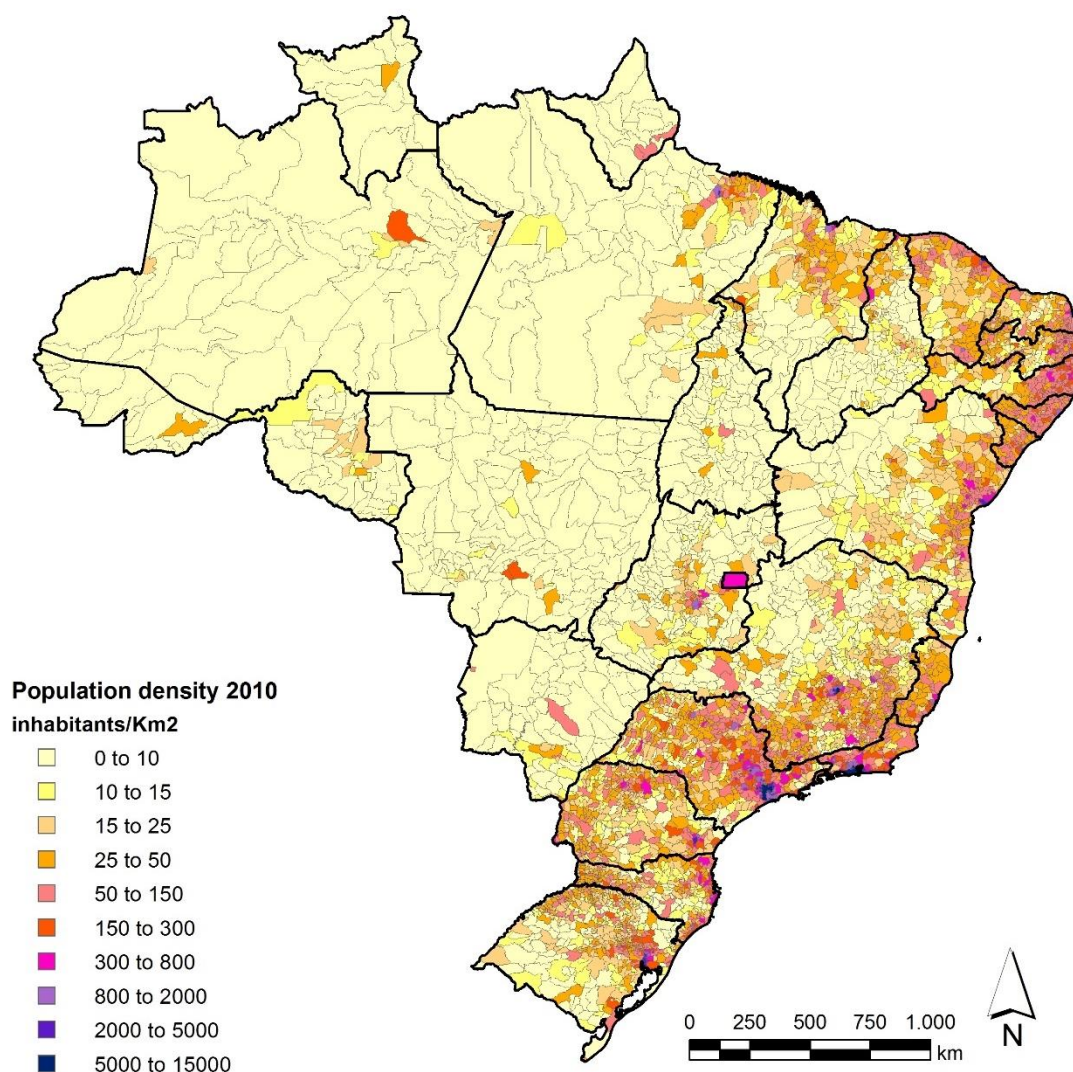
Map 2-1 Dispersal of the respondent population in the territory.



Source and elaboration: The author, 2018.

This concentration of participants may seem disproportionate, however, as shown on **Map 2-2**, most of the country's population is also concentrated in this region. Thus, the proportion of attendants over the general population (estimated at 207 million in 2017) is from 1 to 1.69e-6.

Map 2-2 Brazil's demographic density.



Source: IBGE, 2010. | Elaborated by the author, 2018.

Table 2-1 List of Questions for Population's Perception Questionnaire Regarding Urban Water Courses.

#	Questions	Alternatives
Section 1 (Perception about water courses)		
1	In your opinion, the main watercourse of your city is:	<input type="checkbox"/> River <input type="checkbox"/> Stream (in portuguese "riacho")

#	Questions	Alternatives
		<input type="checkbox"/> Stream (in portuguese "córrego") <input type="checkbox"/> Dam
2	What is the name of this watercourse?	Free answer
3	What is the main use of this watercourse?	<input type="checkbox"/> Water supply <input type="checkbox"/> Transportation <input type="checkbox"/> Recreational use <input type="checkbox"/> Sewer receiver <input type="checkbox"/> No specific use <input type="checkbox"/> Do not know
4	You consider this watercourse to be:	<input type="checkbox"/> Clean <input type="checkbox"/> Polluted
5	In case of "polluted", why do you believe that it is so? (more than one possible answer)	<input type="checkbox"/> Lack of government management / interest <input type="checkbox"/> Lack of interest of the population <input type="checkbox"/> Sewers illegally cleared <input type="checkbox"/> Waste thrown by the population <input type="checkbox"/> Lack of basic sanitation in areas invaded by the banks of the watercourse <input type="checkbox"/> Not applicable <input type="checkbox"/> Others
6	What is the status of this watercourse? (more than one possible answer)	<input type="checkbox"/> Margins with presence of vegetation <input type="checkbox"/> Margins with impermeable material <input type="checkbox"/> Presence of animals <input type="checkbox"/> Presence of fish <input type="checkbox"/> Clean Waters <input type="checkbox"/> Turbid Waters <input type="checkbox"/> Unpleasant odour <input type="checkbox"/> Presence of debris (rubble, litter, etc.) on the banks <input type="checkbox"/> Presence of residues in water (floating material) <input type="checkbox"/> Fast water flow <input type="checkbox"/> Slow or stopped water flow

#	Questions	Alternatives
7	You rate this course as:	<input type="checkbox"/> Very important <input type="checkbox"/> Important <input type="checkbox"/> Indifferent <input type="checkbox"/> Bit important <input type="checkbox"/> Not important
8	In what category of importance do you apply this watercourse?	<input type="checkbox"/> Public health <input type="checkbox"/> Environment <input type="checkbox"/> Both <input type="checkbox"/> None of the alternatives <input type="checkbox"/> Other
9	Would you like to be part of the decision-making process for this watercourse?	<input type="checkbox"/> Yes <input type="checkbox"/> No
10	What measures would you like to be taken in relation to this watercourse? (more than one possible answer)	<input type="checkbox"/> Restoration of the margins (insertion of vegetation) <input type="checkbox"/> Water Pollution <input type="checkbox"/> Creation of linear park in the banks <input type="checkbox"/> Environmental education of the population <input type="checkbox"/> Channeling (in case of rivers and streams)
11	Are you aware of any project to improve the waters and / or the margins of this watercourse?	<input type="checkbox"/> Yes <input type="checkbox"/> No
12	If yes, which one?	Free answer
13	If not, which one do you think is the reason?	<input type="checkbox"/> Total lack of projects <input type="checkbox"/> Lack of disclosure of projects in progress <input type="checkbox"/> Lack of commitment of the population to collect improvement measures <input type="checkbox"/> Do not know <input type="checkbox"/> Others
Section 2 (Residencial structure)		
14	Which of these categories better describe your home?	<input type="checkbox"/> Independent House <input type="checkbox"/> House in condominium <input type="checkbox"/> Land shared with more than one house <input type="checkbox"/> Apartment

#	Questions	Alternatives
		() Other
15	How many bathrooms are there in the house?	() 1 () 2 () 3 () 4 () More than 5
16	Do you have sewage collection in your home (connection to the public collection network)?	() Yes () No () Do not know
17	Counting with you, how many people live in this residence?	Free answer
18	How many adults (over 18 years old)?	Free answer
19	How many children (younger than 17 years old)?	Free answer
20	How many people are employed today?	Free answer
21	What is the type of employment contract?	() Formal work with a formal contract () Formal work as a legal entity (microentrepreneur, etc.) () Informal work (no formal contract) () Not applicable () Others
22*	What is the average monthly family income (the sum of the income of all those who work)?	() Less than one minimum salary (R\$ 954.00) () Between one and five minimum salaries (R\$ 954.00 - R\$ 4,770.00) () Between five and ten minimum salaries (R\$ 4,770.00 - R\$ 9,540.00) () More than ten minimum salaries (over R\$ 9,540.00) () Not applicable
Section 3 (General Information)		
23	What is your age group?	() 14 to 19 y.o. () 20 to 26 y.o. () 27 to 34 y.o. () 35 to 41 y.o. () 42 to 50 y.o.

#	Questions	Alternatives
		() 51 to 60 y.o. () Over 61 y.o.
24	Gender:	() Female () Male
25	What is your level of education?	() Incomplete Elementary School () Complete Elementary School () Incomplete High School () Complete High School () Technical High School () Incomplete Graduated () Graduated () Specialization () Master (MSc) () PhD () Post Doctoral
26	What state you come from?	Free answer
27	What city you come from?	Free answer

*1,00 EUR = 0,23 BRL or 1,00 USD = 0,29 BRL

Source: The author, 2018.

Through this questionnaire it is possible to infer suppositions as:

- The level of understanding of the population about rivers and other watercourses is good enough to call for a change?
- Do they pay any attention to watercourses?
- Is the population aware of the importance of watercourses and what kind of ecosystem services they bring?
- Is this awareness related to the level of education, age and/or gender?

These suppositions will be analysed and discussed in chapter 5.

2.2.3. Case studies

In order to give further evidence to the findings of the literature research, and to learn about the national practices regarding restoration and water governance, case studies from Brazil and the European Union were scrutinised using tools of document analysis. The cases used for this purpose were found in literature and researches on the Science Direct database using the keywords river, stream, restoration and participation. The analysis aimed for information about the location, local hydromorphological specifications,

the aims and measures of restoration, the stakeholder constellation and aspects of governance, such as the distribution of expenses and forms of participation. The information was gathered in separate tables for Europe and Brazil, where direct quotations from the documents were entered. The results were then interpreted in a qualitative way in order to draw conclusions on how governance contributes to river restoration.

3. Concepts and definitions in river restoration – literature review

3.1. Ecosystem services

To explore and understand the importance of restoring rivers and other degraded watercourses, it is imperative to understand the concept of ecosystem services. The importance of the same is not only for ecological issues, but for human well-being and in helping decision-making. According to Balvanera et. al (2016), “monitoring ecosystem services is vital for informing policy (or decision making) to protect human well-being and the natural systems upon which it relies at different scales. Using this information in decision making across all scales will be central to our endeavours to transform to more sustainable and equitable futures”.

As explained in the Introduction chapter, ecosystem services are divided in four categories: provisioning, regulating, supporting and cultural. And for these four categories, it is split in four more components: supply, delivery, contributions to well-being and economic value, summarized as follows, according to Balvanera (2016):

- **Supply:** refers to the potential of a social-ecological system to generate a service, typically quantified as a flow (i.e., an amount per unit time). Ecosystem condition (e.g., intact or degraded, stressed or unstressed) and processes (e.g., primary productivity), as well as the way ecosystems are managed, are taken into account when determining supply. This is the component of ecosystem services that has been most commonly measured.
- **Delivery:** accounts for how much of the service is actually extracted (e.g., amount of timber harvested), used (e.g., area of avoided flood damage, area that is enjoyed by visitors), and delivered to societies (e.g., spatial location of those benefiting from flood regulation), and how societies have access to these services (e.g., laws rules, norms and restrictions that limit access to a service). Delivery thus depends on the links between ecosystem services supply and people’s location, activities and societal factors determining access to services.
- **Contribution to well-being:** accounts for the change in people’s well-being, which results from consuming, using, or having access to the service. Changes in living standards, nutrition status, mortality rates, social conflicts, security in the face of extreme environmental conditions, or happiness partially depend on the delivery of ecosystem services. This component of ecosystem services is the least understood and seldom quantified. One of the issues is that well-being

typically has many components and many causes, so it hard to isolate the contributions of a particular service.

- **Economic value:** here to the relative importance society attributes to the service. The value of ecosystem services is often accounted in monetary terms, but other ways of establishing the socio-cultural value are potentially equally valid, and may be more appropriate than monetary valuation for some services. For instance, contributions to longevity or perceived quality of life need not be expressed in monetary terms. The monetary value of most provisioning services (e.g., timber) is provided by markets.

Still according to Balvanera et al. (2016), where freely-traded markets do not exists (for instance, this is frequently the case for water service), the value can be estimated through a variety of methods, such as the cost of delivering a substitute, or the marginal value addition of the service to other services which do have markets. Valuation approaches, based on willingness to pay, damage costs avoided, travel costs, or hedonic values, have been used to attribute economic value to many regulating and cultural services. Socio-cultural values of ecosystem services to an individual can be assessed through various valuation methods, such as through preference surveys, paired comparisons, and narrative or participatory methods. What is frequently reported is the aggregate societal value resulting from some combination of individual valuations.

Table 3-1 Examples of provisioning, regulating and cultural ecosystem services, including descriptions, drivers and potential indicators for each of the four components of the ecosystem service (supply, delivery, contribution to well-being and value) adapted for rivers and water sources.

Service	Description	Drivers	Ecosystem Service Component			
			Supply	Delivery	Contributions to well-being	Economic value
Provisioning						
Water	Volume of surface water flow and the amount of water stored in groundwater for domestic, industrial and agricultural use	Biophysical (e.g. climatic, land cover) and societal (e.g. location of user, demand per type of user)	Volume of superficial or ground-water available (m³)	Volume of superficial or ground-water withdrawn per user (agricultural production, domestic and industrial)	% of population or water user or economic sector with available water above water needs	Market value of water to agriculture, tourism, industry, etc. (US\$), marginal contribution of irrigation to crop market value
Hydropower generation	Energy produced in dams derived from water	Biophysical (water yield, timing of water release) and	Potential energy produced by	Hydropower energy produced (kW)	% energy needs contributed by wind hydropower, %	Market value of hydropower (US\$),

Service	Description	Drivers	Ecosystem Service Component			
			Supply	Delivery	Contributions to well-being	Economic value
	produced by the watershed	societal (e.g. water consumption, dam location, energy production per dam, energy policies)	hydropower (kW)		GHG emissions reduced by production of hydropower	avoided water replacement costs (US\$)
Transportation	Rivers can be used as waterways by boats and ships for transportation	Need for transportation (economic strength, population, production of goods), size of the river, morphological constraints	Water level, stream size, morphology	Use of the river as waterway	Availability and trade of goods, transport of persons	Income by trade, transport fees
Regulating						
Regulation fresh water quality	Can be impaired by nutrients (P and N), sediment, dissolved organic carbon content, temperature, pH, and concentrations of pathogens or toxic compounds. The abiotic and biotic components of ecosystems can contribute to mitigate such contaminants	Biophysical (e.g. land and sea bottom cover, aquatic biodiversity), management (e.g. fertilization or sewage upstream, water treatment) and societal (e.g. sanitation regulations, water quality standards per type of use)	Mass of nutrients, organic matter, sediments, or toxic organisms or compounds removed (kg), changes in temperature, pH	Water conditions in relation to standards for different water users at or above withdrawal point	Avoided disease by water treatment	Avoided water treatment costs (US\$); cost of wetland construction for nutrient removal (US\$)
Flood regulation	A function of the vegetation and soils that increase infiltration rates and thus reduce the	Biophysical (e.g. climate, soil, aquatic vegetation), management (e.g. hydraulic infrastructure)	Flood volume regulated by vegetation and soils (m ³)	Area of avoided flood damage due to regulation by	Number of people protected from flood by regulation from vegetation and soils	Avoided economic loss by flood regulation from vegetation

Service	Description	Drivers	Ecosystem Service Component			
			Supply	Delivery	Contributions to well-being	Economic value
	amount of surface water flow that contributes to floods	and societal (e.g. people's location, infrastructure characteristics)		vegetation and soils (ha)		and soils (US\$)
Cultural						
All non-tangible benefits	Includes a large array of non-tangible benefits from ecosystems that include heritage (cultural or religious), inspiration (spiritual or artistic), sense of place, identity, social relations, and education, among others	A suite of biophysical (e.g. biodiversity, topography), management (e.g. dominant management activities) and societal (e.g. culture) conditions	Non-material benefits from ecosystems and the interactions among them			
Aesthetic views	Refers to various landscape features that convey aesthetic characteristics that are appreciated and enjoyed	Biophysical (e.g. topography), management (e.g. land use and land cover type), and societal (e.g. access roads or boating areas, number of visitors, cultural preferences)	Area that provides aesthetic views	Area that is enjoyed by visitors or local inhabitants for its aesthetic views, number of visitors	Marginal contributions to income or well-being of visitors and to local inhabitants derived from aesthetic views	Economic revenues derived from visits to aesthetic areas or marginal contribution to real estate prices by aesthetic characteristic (US\$)
Nature-based tourism	A function of multiple characteristics of landscapes, water bodies and biodiversity that determine whether areas	Biophysical (e.g. bird richness, characteristics of water bodies), management (e.g. land use and land cover	Area that is suitable for nature-based tourisms	Area where nature-based tourism occurs, number of visitors	Marginal contributions to income or well-being of visitors and local inhabitants derived from nature-based tourism	Economic revenues derived from or costs associated with undertaking nature-based

Service	Description	Drivers	Ecosystem Service Component			
			Supply	Delivery	Contributions to well-being	Economic value
	are attractive to tourists	type), and societal (e.g. protection status, facilities to support visits, distance from cities)				tourism (US\$)
Recreational	Includes hiking, angling, cycling, birding, swimming, diving, and others	A suite of biophysical (e.g. biodiversity, topography), management (e.g. land use and land cover type) and societal (e.g. access roads or boating areas, number of visitors, facilities to support visits, distance from cities)	Areas that are suitable for recreation-based tourism	Area where recreation-based tourism occurs, number of visitors	Marginal contributions to income or well-being of visitors and local inhabitants derived from recreation-based tourism	Economic revenues derived from or costs associated with undertaking nature-based recreation (US\$)

Extracted and adapted from: Examples of provisioning, regulating and cultural ecosystem services, including descriptions, drivers and potential indicators for each of the four components of the ecosystem service (supply, delivery, contribution to well-being and value), Balvanera et al, 2016, p. 45-55.

These components of ecosystem services feed back into the way social ecological systems are managed and governed. Supply allows for delivery which allows for contributions to well-being which, in turn, influences value. Ecosystem service contributions to well-being, shape the status of and vision for the well-being of individuals and societies, which directly influences the way formal and informal institutions are designed to modulate interactions with the environment. Value determines which services are fostered, and shape institutions and management interventions, aimed at modifying social-ecological conditions to promote the supply of the desired services at the cost of other services (Díaz et al. 2015).

There are still other subdivisions for ES according to the presence or absence of beneficiaries of direct services. The Final Ecosystem Goods and Services classification system (FEGS; Landers and Nahlik, 2013 apud Balvanera et al., 2016) classify ecosystem services in Intermediate (IESS) and Final (FESS). The IESS are the ones in which the

ecosystem provides but are not directly used or appreciated by humans, such as water purification, while FESS are provided and directly used or appreciated by humans, such as the actual use of pure water for drinking. This distinction was also suggested earlier in the UK National Ecosystem Assessment (2011) and by Boyd and Banzhaf (2007) (Gerner et al. 2018 apud Balvanera et al, 2016).

3.2. River restoration

To understand the reasons for a country's environmental problems, it is necessary to understand its historical and cultural problems. Being this a country the size of Brazil this task can be even more complex given the wide climatic, economic and social differences from region to region. Likewise, one must have an understanding of what widely explored concepts means in the context of that country. River restoration, for example, was recognized as essential to re-establish functions of the rivers (EU 2000; SER 2004; Millennium Ecosystem Assessment 2005; Jørgensen 2015) but face a diversity of interrelated problems and many local specificities (Walsh et al. 2005).

The 16 most commonly used (Morandi 2014) can be grouped into four categories: 1) Ecological Urban River Restoration definitions with focus on the return of the ecosystem to a previous status; 2) Definitions with focus on (long-term) sustainability in ecosystem structure and function; 3) Comprehensive definitions that consider social functions of the river; and 4) Practical definitions of river restoration listing the restoration measures considered. (Table 3-2).

Table 3-2 Synthesis of the main definitions of river restoration published in the international literature.

Category	Definition	Author
1) Ecological Urban River Restoration definitions with focus on the return of the ecosystem to a previous status	"restoration implies return of an ecosystem to a close approximation of its condition prior to disturbance"	Shields et al., 2003
	"an acid test for ecology"	Bradshaw, 2002
	"should be defined as returning an ecosystem to its condition prior to disturbance (if known and possible), or, as in most cases, to a state as similar as possible to that prior to disturbance"	Amoros, 2001
	"implies full return to a prior structure and function"	Brookes & Shields, 1996
	"restoration, by its strictest definition, as a return to the original conditions"	Gore & Shields, 1995
	"Restoration means returning an ecosystem to a close approximation of its condition prior to disturbance. Accomplishing restoration means ensuring that the ecosystem structure and functions are recreated or repaired and that natural dynamic ecosystem processes are operating effectively again"	N.R.C., 1992

Category	Definition	Author
	"the complete structural and functional return to a pre-disturbance state"	Cairns, 1991
	"the act of restoring to a former state [...] or to an unimpaired or perfect condition"	Bradshaw, 1996
	"the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed"	Society for Ecological Restoration (SER), 2004
2) Definitions with focus on (long-term) sustainability in ecosystem structure and function	"Restoration is a complex endeavor that begins by recognizing natural or human-induced disturbances that are damaging the structure and functions of the ecosystem or preventing its recovery to a sustainable condition"	F.I.S.R.W.G., 1998
	"minimize human-mediated constraints, thereby allowing natural reexpression of productive capacity"	Stanford et al., 1996
	"Restore the most probable form [...] and the effective design for the most long-term stability and function"	Rosgen, 1994
3) Comprehensive definitions that consider social functions of the river	"repairing waterways that can no longer perform essential ecological and social functions"	Palmer & Bernhardt, 2006
4) Practical definitions of river restoration listing the restoration measures considered	"river restoration is a term applied to a wide range of specific management activities, from replanting riparian trees or fencing live-stock out of stream corridors to the removal of dams and full-scale redesign of river channels"	Bernhardt et al., 2007b
	"restoration projects must recreate the physical conditions needed to maintain natural communities, including substrate, water depth and velocity, inundation frequency, and temperature"	Kondolf & Micheli, 1995
	"a historically influenced exercise in environmental enhancement through morphological modification"	Downs et al., 1991

Adapted from: Zingraff-Hamed et al. 2017a

In the case of Brazilian rivers, we can consider the definitions included on the categories: 3) Comprehensive definitions that consider social functions of the river and 4) Practical definitions of river restoration listing the restoration measures considered, for a start. When these points become part of the governance it can evolve to categories 1 and 2.

3.3. Governance

For the purpose of this analysis and definition of the concept of governance, several authors were selected who share ideas and definitions on the subject, in order to conform concepts considered more applicable to the defined problem.

According to the United Nations Development Programme (2001, apud Rogers & Hall, 2003, p. 7), governance is the exercise of economic, political and administrative authority to manage a country's affairs at all levels. It comprises the mechanisms, processes and

institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences.

For Stoddart (2011, p.1) the concept of 'sustainable development governance' is potentially vast, as governance touches almost all decisions and policy considerations at all levels. So, based on the Rio Declaration and the UN Conference on Environment and Development, both from 1992, she points the most important concepts and principles that will be important in considering the merits of different proposals to strengthen the institutional framework for sustainable development. These seven principles are namely: 1) The precautionary principle; 2) Polluters pay principle; 3) Common but differentiated responsibilities; 4) Access to information, participation and justice; 5) The Global Commons; 6) Intergenerational equity; and 7) Commonwealth principles on the reform of international institutions. Throughout this work, the principles 2, 4 and 5 will be exploited and explained.

Yet, water governance, according to the Global Water Partnership (2002) refers to the range of political, social, economic and administrative systems that are in place to develop and manage water resources, and the delivery of water services, at different levels of society. For Tundisi (2008, p.9), it is a decentralization movement that exists to promote a management, basically, by hydrographic basin, which is a biogeophysiographic unit, containing all the elements for the integration of biogeophysical, economic and social processes.

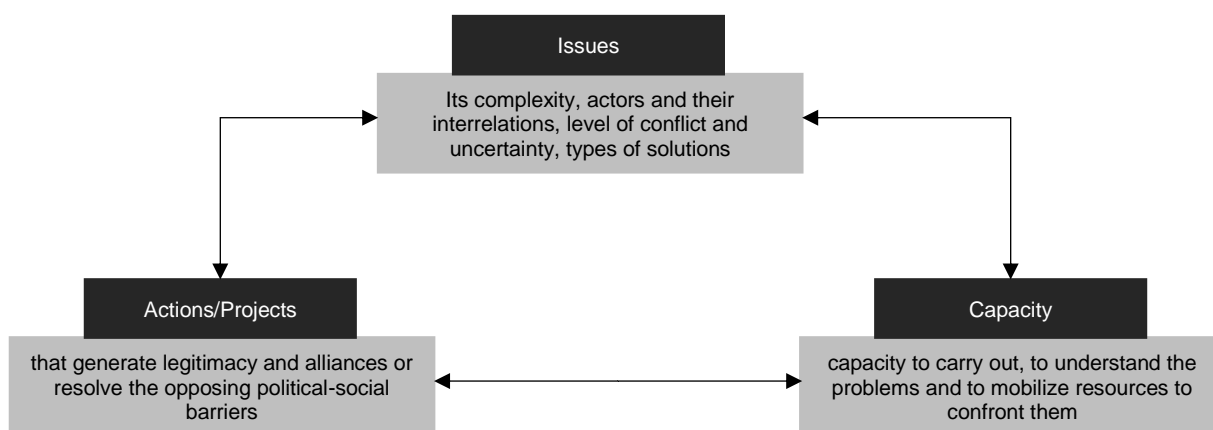
For Pagnocchesci (2016, p. 176), one cannot deal with governance without also talking about governability; for the theme of water resources, they are complementary and inseparable concepts. Quoting Alcindo Gonçalves in the document "The concept of governance", while governance has an essentially state dimension, linked to the political-institutional system, governance operates on a broader plane, encompassing the whole of society.

Weiss (2016, p. 329) notes that governability is defined by the rules and conditions under which exercise of power; depends on the dynamic balance between the level of society's demands and the capacity of the public and private institutional system to process them. It consists of the relationship between three components: problems, ability to face them, and accomplishments. Governance is the ability to transform the governmental act in public action; result of the sum of the various forms with which public and private persons and institutions manage their affairs in through continuous processes that accommodate conflicting interests. The level of articulation and the capacity to act depends on the actors, the formal institutions and of the informal involved arrangements and their decision-making

processes. For each sector of the civil society, the two concepts interact in the search of influencing governability so that governance is effective with the policies of its interest.

Matus (1987, Weiss et al., 2007, p.11-32 apud Weiss, 2016, p.330) defines governability from the relations between three components that form the triangle of government (Figure 3-1): problems, ability to face them and actions / projects.

Figure 3-1 Concept of governance according to the situational strategic planning.

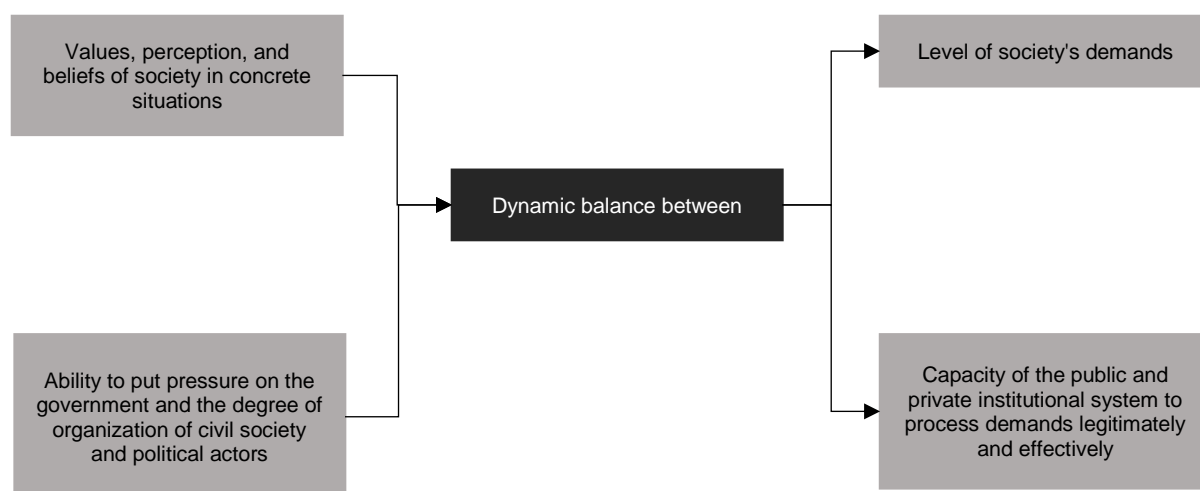


Source: Weiss (2016). Elaborated by the author (2018).

It is clear that governance is not restricted to a management problem nor to a problem of government. It is another combination of interactions between society, government and market, which determine the degree of governability, along with instruments such as: established, legitimate and efficient channels, and community mobilization and involvement in the design and implementation of policies.

Weiss (2016, p. 331) goes on to say that governability depends on the dynamic balance between the demands of society and the capacity of the public and private institutional system to process them legitimately and effectively. It is also conditioned by society's values and its capacity for pressure on government (Figure 3-2).

Figure 3-2 Dynamic balance of governance.



Source: Weiss (2016). Elaborated by the author (2018).

In this way, governability concerns the structural and legal conditions of government to promote the necessary transformations. Governance is related to the capacity to transform the government act into public action, articulating government actions and involving concepts such as participation, partnership, collective learning, regulation, and best practices (Malo, 2000, Câmara, 2011 apud Weiss, 2016, p. 332).

Table 3-3 organizes these concepts explored by Weiss and identifies how they can relate.

Table 3-3 Governance and governance: State and Society.

Concept	State	Society
Governability	<ul style="list-style-type: none"> • Systemic conditions of the exercise of power: <ul style="list-style-type: none"> - Form of government - Relations between powers - Party system etc. 	<ul style="list-style-type: none"> • Legitimate and efficient instruments as established channels • Mobilizing and involving the community in policy-making
Relation of governability with governance	<ul style="list-style-type: none"> • Relation of the systemic conditions with the capacity of execution of public policies 	<ul style="list-style-type: none"> • Relationship of the exercise of power with movements and groups representing society • Influence of the form and strength of civil society participation in governance effectiveness and governance.
Governance	<ul style="list-style-type: none"> • Capacity for state action in the implementation of policies and in the achievement of collective goals • Financial, social and administrative conditions for implementing policies • Power to exercise authority 	<ul style="list-style-type: none"> • Relationship of the exercise of power with movements and groups representing society • Influence of the form and strength of civil society participation in

Concept	State	Society
		governance effectiveness and governance.

Source: Weiss (2016). Elaborated by the author (2018).

Wantzen (unpublished, 2018) pointed the common problems of poor governance in the countries of the Global South such as lack of public money, lack of legal reinforcement, ignorance of the problem by the politicians, cronyism and lobbyism from abroad. In addition, urban planners hardly have any awareness of biodiversity and ecosystem functions, water quality or the link between well-being human health and ecosystem health focusing only in the concern of hydrological issues (such as floods).

On the other hand, developed countries, such as European ones, face other issues, as pointed by Rogers & Hall (2003, p. 11): fiscal crises within the State (limitations on raising taxes), technological advances that facilitate networking and subsidiarity, the globalisation process, including deregulation of financial markets, and volatility of capital, which restricts the State's ability to govern/control the economy, a more assertive sub-national democracy in cities or semiautonomous regions, excessive workload and responsibilities on smaller government bureaucracies; and large concentrations of people and political power in urban areas.

Governance matters a great deal for economic, social and environmental outcomes. Some necessary conditions for good governance are inclusiveness, accountability, participation, transparency, predictability and responsiveness. When the governing system does not fulfil these conditions, we talk in terms of poor governance. Poor governance leads to increased political and social risk, institutional failure and rigidity and a deterioration in the capacity to cope with shared problems (Rogers & Hall, 2003, p. 9).

4. River restoration and water governance in Brazil and the EU: research results

4.1. Brazil

4.1.1. Legislation

The first step in guaranteeing the protection and maintenance of surface and underground water quality is the existence of a solid normative base, which should be used and supported for design project and for the collection of improvement actions by the government and the population. Even though environmental laws in Brazil are among the most complete and advanced in the world, it is extremely difficult to maintain the minimum water quality levels both in rural and urban areas. Also, it is hard to keep up any changes or updates once population is not well informed about the possibilities of participation

In Brazil, all laws, regulations, plans and provisional measures are based on the Federal Constitution of 1988, which, after two decades of military authoritarianism, marks the re-encounter of the Brazilian people with democracy and with the full guarantee of human fundamental rights, among which the environment appears for the first time in Brazilian constitutional texts (MARUM, 2002, p. 133, apud MACEDO, 2015).

The main laws and resolutions regarding the protection of water and the environment are listed, with emphasis on the protection of water resources, followed by fragments of the text that elucidate part of the content focused on restoration, but without distorting the interpretation of the whole. The underlined texts were made by the author in the intent of highlight points for further discussion. The regulations are:

- **The Federal Constitution of 1988**, Art. 225: "Everyone has the right to an ecologically balanced environment, a common good used by the people and essential to a healthy quality of life, imposing on the Government and the community the duty to defend and preserve it for present and future generations."
Paragraph 1 - To ensure the effectiveness of this right, it is incumbent upon the Public Power:
I - To preserve and restore the essential ecological processes and to provide the ecological management of the species and ecosystems; (...) "
- **National Policy of Environment** ("Política Nacional de Meio Ambiente"), Law nº 6.938, 31 August 1981, Art. 2º: *"The National Environmental Policy aims at preserving, improving and recovering the environmental quality conducive to life, aiming to ensure, in the country, conditions for socio-economic*

development, national security interests and protection of the dignity of human life, served following principles:

I - governmental action in maintaining the ecological balance, considering the environment as a public patrimony to be necessarily assured and protected, in view of the collective use;

II - rationalization of land, subsoil, water and air use;

III - planning and inspection of the use of environmental resources;

IV - protection of ecosystems, with the preservation of representative areas;

V - control and zoning of activities potentially or effectively polluting;

VI - incentives for the study and research of technologies oriented towards the rational use and protection of environmental resources;

VII - Monitoring the state of environmental quality;

VIII - Recovery of degraded areas; (Regulation)

IX - Protection of areas threatened with degradation;

X - Environmental education at all levels of education, including community education, in order to enable it to participate actively in environmental protection. "

Article 4 further establishes: "The National Environmental Policy shall aim at: (...)

V - the dissemination of environmental management technologies, the dissemination of environmental data and information, and the formation of a public awareness of the need to preserve environmental quality and ecological balance;

VI - the preservation and restoration of environmental resources with a view to their rational use and permanent availability, contributing to the maintenance of the ecological balance conducive to life;

VII - to the imposition, the polluter and the predator, of the obligation to recover and / or indemnify the damages caused and to the user of the contribution for the use of environmental resources for economic purposes."

- **National Policy of Water Resources** ("Política Nacional de Recursos Hídricos"), Law nº 9.433, 8 January 1997, Chapter I – Fundamentals, Art. 1: "*I - water is a public domain good; (...), VI - the management of water resources must be decentralized and count on the participation of the Public Power, users and communities."*

- **Forestry Code** (“*Código Florestal*”), Law n° 12.651, 25 May 2012, Art. 1°: *“With the objective of sustainable development, this Law shall comply with the following principles:*
I - affirmation of Brazil's sovereign commitment to the preservation of its forests and other forms of native vegetation, as well as biodiversity, soil, water resources and the integrity of the climate system, for the well-being of present and future generations;” and *“(…) IV - joint responsibility of the Federal Government, States, Federal District and Municipalities, in collaboration with civil society, in the creation of policies for the preservation and restoration of native vegetation and its ecological and social functions in urban and rural areas;”*
“Article 3 For the purposes of this Law, the following definitions shall apply: (…)
II - Permanent Preservation Area - APP: protected area, covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability and biodiversity, facilitating the gene flow of fauna and flora, protecting the well-being of human populations;(…)”
- **Law of Environmental Crimes** (“*Lei de Crimes Ambientais*”), Law n° 9.605, 12 February 1998, Chapter 5, Section III “Pollution and Other Environmental Crimes” provides imprisonment and / or penalty for the following actions: “Art. 54. To cause pollution of any nature at levels that result or may result in damages to human health, or that cause the death of animals or the significant destruction of flora (…); § 2 If the crime:
I - make an area, urban or rural, unfit for human occupation;
II - to cause atmospheric pollution that causes the withdrawal, even if momentary, of the inhabitants of the affected areas, or that causes direct damages to the health of the population;
III - cause water pollution that necessitates the interruption of the public water supply of a community;
IV - hinder or prevent public use of beaches;
V - occur by discharge of solid waste, liquid or gaseous, or debris, oils or oily substances, in disagreement with the requirements established in laws or regulations (…); and Art. 61. Disseminate disease or pest or species that may cause damage to agriculture, livestock, fauna, flora or ecosystems”

- **Resolution 357/05 of the National Environment Council (CONAMA):** It deals with the classification of water bodies and environmental guidelines for its classification, as well as establishes the conditions and standards for the discharge of effluents and provides other measures.

Other important laws to be cited are:

- **National Policy on Basic Sanitation** (*“Política Nacional de Saneamento Básico”*), Law n° 11.445/2007: Establishes the National Policy on Basic Sanitation - Versa on all sectors of sanitation (urban drainage, water supply, sewage and solid waste).
- **National System of Nature Conservation Units** (*“Sistema Nacional de Unidades de Conservação da Natureza”*), Law n° 9.985/2000: Establishes the National System of Nature Conservation Units, among its objectives are the conservation of varieties of biological species and genetic resources, the preservation and restoration of the diversity of natural ecosystems and the promotion of sustainable development from the natural resources.
- **Urban Land Instalments** (*“Lei do Parcelamento do Solo Urbano”*), Law n° 6.766/1979: Establishes rules for urban subdivisions, prohibited in ecological preservation areas, in areas where pollution poses a danger to health and in marshy lands.
- **Public Civil Action** (*“Lei da Ação Civil Pública”*), Law n° 7.347/1985: Treats the public civil action for damages caused to the environment, the consumer and the artistic, tourist or landscape patrimony, which is the responsibility of the Brazilian Public Prosecutor's Office.

It is important to remember that the enumerated laws are only part of the Environmental Law of the Country, which still has countless other matters, such as decrees, resolutions and normative acts. There are also regulations of organs committed to comply with laws, such as the National Environment Council (CONAMA) and the Ministry of Environment.

Therefore, in summary, it can be said that Brazilian laws, plans and resolutions seek to guarantee the biological and physical-chemical quality and protection of surface waters through parameters and directives, in addition to appointing inspection bodies and

evaluators and, legal and penal sanctions in case of non-compliance with the proposed measures.

4.1.2. Situation of the rivers

Urban growth in the last decades has transformed Brazil into an essentially urban country - 83% of the population lives in large centers (Tucci, 2008) and this has had major impacts on surface waters (i.e. lack of sewage treatment, lack of urban drainage system, occupation of the riverbed floodplain, impermeabilization of the riverbed, canalization, among others) and the conservation of these waters has become difficult. The author explains the four phases of the development of urban water: 1) Pre-Hygienist Phase; 2) Hygienist Phase; 3) Corrective Phase; and 4) Sustainable development Phase, as resumed in the Table 4-1.

Table 4-1 Phases of urban water development.

Phase	Characteristics	Consequences
Pre-Hygienist: until the beginning of the 20th century	Sewage in septic tanks or directly into the drainage system, without collection or treatment and nearest source of water, well or river.	Diseases and epidemics, high mortality and floods.
Hygienist: before 1970	Transportation of sewage away from people and canalization of the drainage system.	Reduction of diseases, but contaminated rivers, impacts on water sources and floods.
Corrective: between 1970 and 1990	Treatment of domestic and industrial sewage, flow damping.	Restoration of rivers, remaining diffuse pollution, hydraulic works and environmental impact.
Sustainable development: after 1990	Tertiary and stormwater treatment, new developments that preserve the natural system.	Environmental conservation, flood reduction and improvement of quality of life.

Adapted from: Aguas Urbanas. Tucci, 2008.

Considering the low percentage of 65% of the households with a sewage collection network¹ (and including households with septic tanks), Brazil is still in the pre-hygienic phase, not only in the rural areas, where less than 10% of households owe this collection, but also in urban areas (near to 75%), where in most cases, the hydrosystems have become transformed into concrete canals or basins, their water quality is extremely bad, banks and riparian zones are used as dumping sites (relying on the next flood that carries the garbage away), and the people living near or passing by the water bodies perceive

¹ Source: National Survey by Sample of Households 2015 from the Brazilian Institute of Geography and Statistics (IBGE – Instituto Brasileiro de Geografia e Estatística).

them as negative because the water has an ugly color and smell, and harbors vectors of water-borne diseases. Very often, the riparian zones are inhabited by the poorest part of the population, which has neither the political power nor the technical skills to manage or develop them in a sustainable way. A great number of these hydrosystems cannot be seen any more, because they were buried and covered by asphalt to create space for roads.

According to Wantzen (2018), a range of factors are responsible for this situation:

1) Urban population growth, as well as sprawl and squatting due to rural exodus growth overrunning a concept-based planning.

2) Fast development of societies unleashes the entire historical development of man-made river degradation very fast, i.e., all problems for environmental restoration occur simultaneously.

3) Hydrological conditions, especially in Tropical countries, are particularly hit by Global Change (massive rainfall events, prolonged droughts, increased stochasticity of hydrological events).

4) Migration of fugitives from politically instable areas into the cities causes badly predictably and massively increasing demands for riverine ecosystem services such as drinking water supply and waste water disposal.

5) Governance problems, e.g., lack of public money, lack of legal reinforcement, cronyism and lobbyism from abroad make restoration projects difficult.

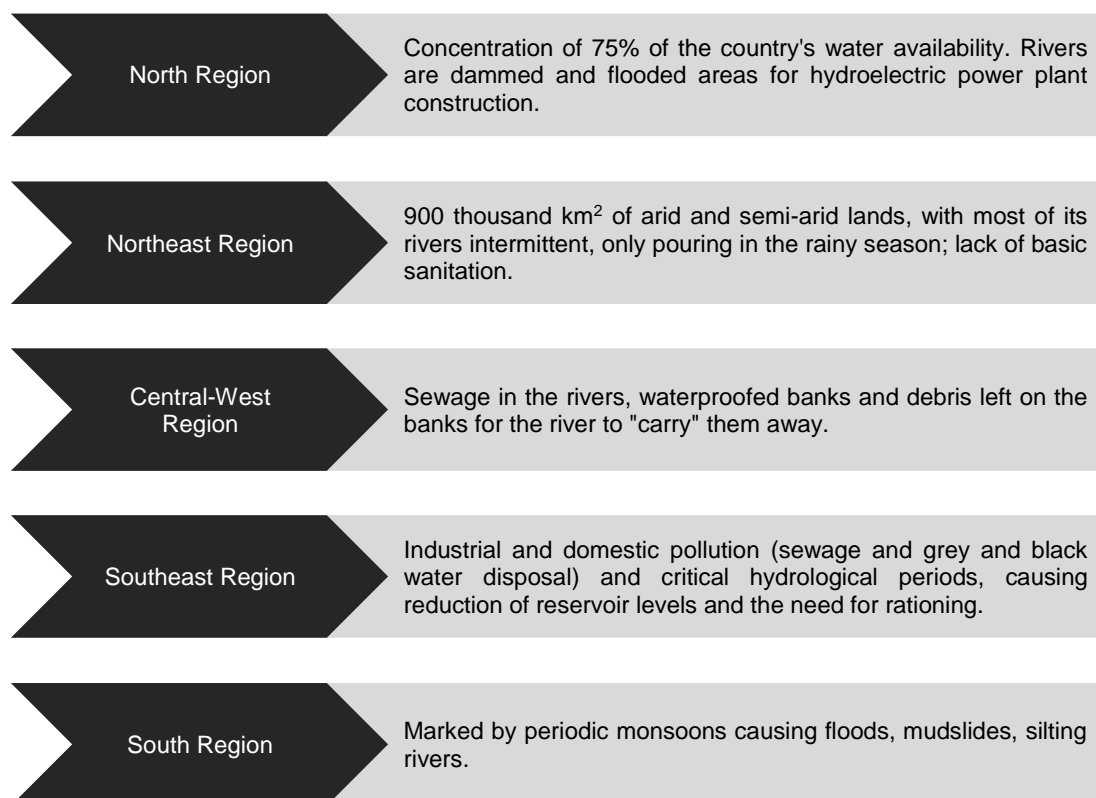
6) Concepts for urban river restoration in developing countries are virtually absent.

Freshwater hydrosystems are most often literally “forgotten” by urban planners in Brazil. Cities grow, often beginning with the most appropriate sites for settling, which are close enough to a river system to profit by the transport, food, and water delivering ecosystem services but sufficiently far away from them to avoid flood problems. At a given moment, urban expansion reaches the borders of the hydrosystems, which are in most cases already strongly polluted. The specific nature of the freshwater ecosystems is often ignored by the way the construction takes place. This “ignorance of the problem” has severe consequences for the well-being of the citizens, for the biological and cultural diversities that are linked to water (Wantzen et al. 2016), and for ecosystem services by the hydrosystems that are the life support systems for humanity even far outside the urban perimeter.

To talk about the problems and conditions of rivers and streams in Brazil is somewhat complex, since this reality changes region in the region, whether due to climatic, cultural,

social issues or even financial incentives. Figure 4-1, below, serves to illustrate the different violence that watercourses suffer in the country, from region to region. In addition to the differences in availability of this resource and how it influences its treatment and perception.

Figure 4-1 Characterization (generalized) of the main problems faced by the water courses by region of Brazil.



Elaborated by the author, 2018.

The northern region of the country concentrates the largest amount (75%) of freshwater in the territory, where only about 10% of the Brazilian population lives (4,12 inhab/km²). Due to this massive availability of water, several rivers were dammed to create hydroelectric plants (the country's main energy matrix) that will supply mainly the central and southern regions. Even with all this availability of water, disregard for the watercourses is great, since the region is also the one with the lowest rate of sewage collection and treatment (only 22,6% according to the National Survey by Household Sample 2015, conducted by the Brazilian Institute of Geography and Statistics - IBGE).

The northeastern region, with a vast arid area and intermittent rivers, has only 3% of the water resources concentration and lacks more water distribution projects (such as the Sustainable Water Resources Development Program of the Brazilian Semi-Arid Region (*Proágua / Semiárido*), but also improvements in the basic sanitation system for both rural

and urban areas, where the problems are more or less similar to those in the (more developed) southeast region of the country.

The central-west region is the second largest in the country's drinking water supply (15%) and accounts for 6% of the Brazilian population (8,7 inhab/km²). Although it has a good relation between water availability and population, it is the region that most waste treated water, has a low rate of collection and treatment of sewage (53%) and its rivers in urban centers are largely channeled, with waterproofed and used margins often as an irregular waste deposit.

The southeastern region, the most developed and populated region of the country (86 inhab/km²), has only 6% of the water concentration and although it has the highest percentage of residences with collection and treatment of sewage (88%), its rivers suffer illegal eviction of domestic and industrial effluents, rectification and waterproofing of the banks, channeling, among other interferences.

Finally, the southern region also has only 6,5% of the concentration of water resources, but with a higher distribution balance with a population density of 48 inhab/km² (15% of the Brazilian population). This region, in addition to the problems presented in the other regions, such as problems in the basic sanitation system and water distribution due to critical hydrological cycles, also presents strong monsoons that cause floods and landslides that later cause silting of the rivers and higher concentration of diffuse pollution.

In general, what we can observe is that, despite the poor distribution of water in the Brazilian territory, even areas with less water availability can be correctly supplied if there are social planning and public actions, mainly through the conservation and restoration of rivers and fountains in order to guarantee the preservation of this strategic and vital natural resource.

To better elucidate these problems, the city of São Paulo, in the Southeast of the country, is a good example to be used. In its more than 1.500 km² area, the city of São Paulo has more than 500 superficial water courses, of which, according to the Rivers and Streets Association (*Associação Rios e Ruas*), more than 300 were channeled and concreted and many others rectified as the Tietê, Anhangabaú and Tamanduateí rivers, that also had their margins concretized.

Since the beginning of the twentieth century, the model of urban planning was based, according to the statement of Professor Alexandre Delijaicov of the Project's Department of the Faculty of Architecture and Urbanism of the University of São Paulo in his participation in the documentary "Entre Rios" (Between Rivers), in a "road based" model

initially proposed by Francisco Prestes Maia, then mayor of the city (1938 – 1945). He elaborated and executed the “Plano de Avenidas da Cidade de São Paulo” (Avenues Plan of the City of São Paulo), which consisted of a concentric radial model of avenues with the purpose of increasing the sale of automobiles and "modernizing" the city using the floodplains and wetlands of the rivers - which were unfit for the real estate market and were empty spaces in the city, guaranteeing low costs with expropriations and increasing the value of the land around, when the construction were finalized.

This plan totally ignored the importance of the rivers and as the city expanded, with each lowering lands, the stream was channeled and transformed into an avenue. Due to the lack of adequate sanitation system in the past decades, rivers were seen as synonymous of dirt (since they received the sewage directly into their floodplains) and sewage runoff only, making this concept of "bury" and rectification of rivers become synonymous with progress, being rooted even in the subconscious of the population. This view of the population will be further explored in the following items.

The rivers that remain (somehow modified but not concretized) receive daily tons of domestic and industrial effluents, due to irregular connections made by the population and of an inefficient and insufficient collection network, the lack of inspection by the environmental agencies of these connections irregular, diffuse pollution. The Tietê River and the Tamanduateí River, for example, two of the most important in the city, have their water quality index (“IQA – *Índice de Qualidade da Água*”) considered to be bad according to the report on monitoring the quality of the waters of the Mata Atlântica basins (“*Relatório Técnico - Observando os Rios 2017 O retrato da qualidade da água nas bacias da Mata Atlântica*”) conducted by the NGO SOS Mata Atlântica in 2017. This index is obtained through the sum of the results of physical, chemical and biological parameters found in the water samples to evaluate the environmental condition of the surface fresh waters. The parameters that make up the IQA are considered as the most relevant ones to be included in the evaluation of water intended for public supply and multiple uses, namely: water temperature, ambient temperature, turbidity, foams, floating waste, odour, sediment, presence of fish, larvae and red worms, larvae and white worms, total coliforms, dissolved oxygen (OD), biochemical oxygen demand (BOD), hydrogenation potential (pH), phosphate (PO₄) and nitrate (NO₃).

The Tamanduateí was rectified, channeled (with vertical margins, that do not give space for the river to "grow" in the periods of flood) and concretized in certain points; the Tietê was rectified, had its and its banks were waterproofed; being a lowland river – lentic and meandering – suffers even more with its rectification.

However, after repercussions of the agreements signed during the United Nations Conference held in the state of Rio de Janeiro (alias Rio 92 or Eco 92), the then government of the state of São Paulo presented a project to clean up the Tietê river and revitalize its banks, the Tietê Project. The project had to be carried out in two distinct stages within five years, and with a budget of US \$ 2,6 billion (divided between the state government and the Inter-American Development Bank (IDB)): two sewage treatment plants, and completion of a third one already under construction and the expansion of a fourth (five in all); 1.500 km of sewage collection networks to serve 250.000 new household connections; 315 km of trunk collectors (to take the sewage from the domestic collection to the interceptors); and 37 km of interceptors (2,80 meters in diameter along the rivers that carry the sewage to the treatment plants).

This project is considered by the state government itself as "the largest sanitation project in Brazil". Currently, the project is in a fourth stage and has already consumed about U\$ 2,4 billion. Although detailed information is difficult to access, according to SABESP (Basic Sanitation Company of the State of São Paulo), responsible for the administration of the project, the same was started due to a social movement with a petition requesting the de-pollution of the river signed by 1,2 million people and the targets set for the first stage were met. The second stage (from 2000 to 2008) aimed to expand and optimize the collection and transportation system for full utilization of installed treatment capacity. 1.600 km of networks and stem collectors were implemented and 290.000 household connections were made to the public collection network. The investment was U\$ 500 million, of which U\$ 200 million was paid by the Inter-American Development Bank (IDB) and U\$ 300 million with own resources of the state government.

In its third phase (2009 to 2015), the objective was to improve the environmental quality in the Alto Tietê Basin, in the Metropolitan Region of São Paulo. With an estimated total investment of U\$1,05 billions², more than 580 km of trunk collectors were installed, 1.250 km of collecting network, 200.000 household connections to the public collection network and expansion of the treatment capacity of the stations by 7,4 m³/s. No official information about the fourth phase was found and attempts to contact with potential project administrators in the environmental company have not been successful.

² U\$ 87 millions from the AB Loan, U\$ 168 million from the Nacional Bank for Development (BNDES – "*Banco Nacional para o Desenvolvimento*") and U\$ 800 millions from the BID Program (U\$ 600 millions from BID and U\$ 200 millions from the State of São Paulo government).

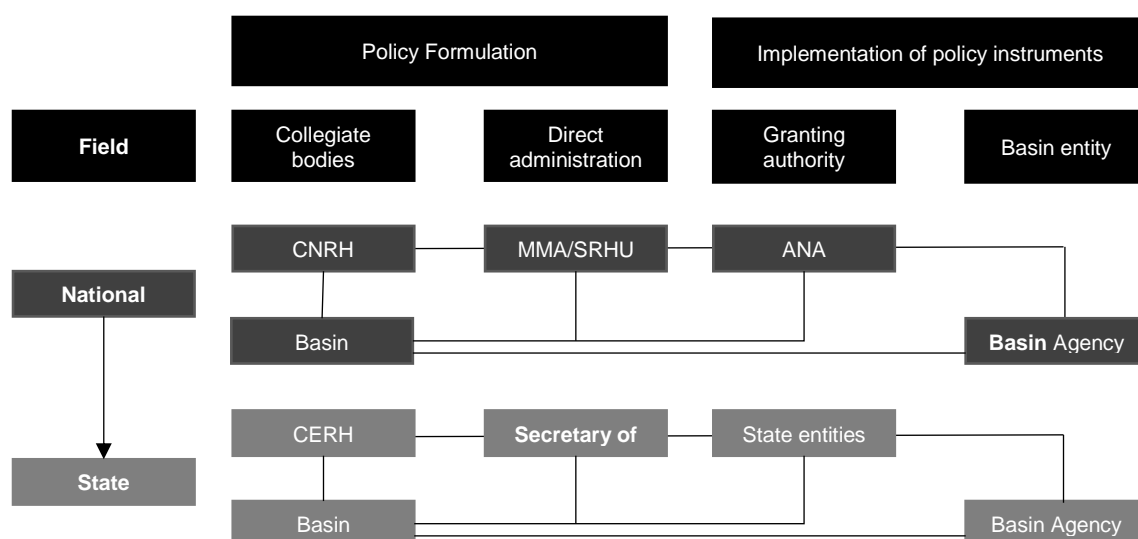
4.1.3. Governance and Restoration Planning

Issues related to water governance and governability are of strategic importance in Brazil, since the quantity and magnitude of Brazilian rivers are unparalleled in the world (Pagnoccheschi, 2016, 175).

The federation structure of the Brazilian State, associated with a water heritage with unique characteristics (more than 75% of the water availability occurs in the North region, which concentrates little more than 10% of the Brazilian population. 900,000 km² of arid and semi-arid lands, with most of its rivers intermittent, only pouring into the rainy season), imposes the need for comprehensive and plural governability and governance processes to discipline the access and the allocation of water in different geographic and climatic contexts (Pagnoccheschi, 2016, p.175). These governability and governance processes, as mentioned previously in Chapter 4 of this paper, are complementary and inseparable concepts - while governability has an essentially state dimension, linked to the political-institutional system, governance operates on a broader plane, encompassing all society.

In order to guarantee these processes, the country has a rich legal framework, as well as a complex system of agencies, committees and councils (Figure 4-2) to ensure the application of this broad system of laws to base decision-making on quality maintenance of water and its multiple uses.

Figure 4-2 Flowchart of Water Resources Management in Brazil.



Councils (CNRH and CERH) - to subsidize the formulation of the Water Resources Policy and settle disputes.

MMA (Ministry of the Environment) / SRHU (Secretariat of Water Resources and Urban Environment) - formulate the National Water Resources Policy and subsidize the formulation of the Union Budget.

ANA (National Water Agency) - implement the National System of Water Resources, grant and control the use of water resources of the Union's domain.

State Body - to grant and supervise the use of state water resources.

Basin Committee - decide on the Water Resources Plan (when, how much and for what to charge for the use of water resources).

Water Agency Technical Office of the Basin Committee.

Source: Ministry of the Environment. Adapted by the author.

The governance of water resources in the country is understood as the form and processes through which water policy is implemented within states and the federal government. One of the major challenges facing governments and society is the greater integration of governance and the deepening of governance processes. As examples to correct this problem, there is the National Water Resources Policy (PNRH), which points out necessary reforms and adaptations, assuming that collaboration is fundamental to the design of a more adequate future in terms of water availability. To promote such collaboration, it creates a management system with the following characteristics: decentralization, participation, integration, coordination and shared financing.

However, the reform proposed by the PNRH is not complete and there are many gaps to be corrected. According to the OECD's Report on Governance of Water Resources in Brazil (2015), there are three important changes in public debate that can support better governance of water resources. First, there is the crucial role of states in managing water resources. Governance in a river basin will hardly occur without state strengthening; as well as integrated federal water resource management cannot be achieved without integrated state water management.

Second, there is the fact that stakeholder engagement and widespread social mobilization should not exclude sound technical expertise and the exercise of public authority. Third, the recognition that bottom-up approaches need to be complemented by a top-down process to ensure compliance with national goals and long-term goals.

In any case, the National Water Agency (ANA) launched in 2003 an initiative called The National Pact for Water Management, aiming to increase the degree of governance of water resources in the federal states. Regarding depollution and river restoration, ANA also elaborated a program aimed only at the depollution of hydrographic basins, the *"PRODES - Programa de Despoluição de Bacias Hidrográficas"*.

The National Pact for Water Management aims to build commitments among the Federated States, aiming at overcoming common challenges and promoting the multiple and sustainable use of water resources, especially in shared basins. This major objective is broken down into two more specific ones: i) promotion of the effective articulation between the water management processes and the regulation of their uses, conducted in the national and state spheres; and ii) strengthening of the Brazilian model of water governance, integrated, decentralized and participatory.

For the implementation of the pact the following structuring elements are considered:

1) Management map: understood as the result of each state's vision of its future challenges regarding the management of its water resources, which, as a whole, will define a bigger picture for the country.

2) Control points: it is necessary to agree on qualitative and quantitative targets of Brazilian rivers, especially those that cross state boundaries, in which points of intersection of the domains must have commitments of the Federated Entities involved, including a bundling of sectorial policies.

3) Harmonized management tools: it is necessary to recognize that, in parallel with the strengthening of the secretariats and the management bodies, it is necessary to work together to identify and correct possible discontinuities or disconnections in the transition of water resources management domains.

4) Sectorial articulation: the user sectors play a fundamental role in the context of water management. In Brazil, although subject to the technical and administrative processes of public authorizations and concessions, these sectors generally have great autonomy as regards the definition of their intervention plans, without the Union or the federal states exercising the desired role of mediation, through regional development plans.

Three mechanisms are considered fundamental to support the desired pact.

1) Definition of criteria of criticality of the river basins and of the minimum set of management instruments and technical personnel corresponding to this level of criticality. Thus, basins with low levels of criticality require only basic management instruments and a smaller contingent of personnel, whereas for basins of high criticality, more complex instruments and a larger and more qualified personnel contingent are required.

2) Definition of the control points and the quantitative targets. The control points are proposed by ANA, as well as the basic control parameters at each point; these points and parameters will then be agreed between the states involved in these border and cross-border basins.

3) Payment for results. To the extent that the management instruments are implemented in each state, according to the required criticality / complexity, the Federative Unit will receive, after the results are obtained, a value defined as payment for results, corresponding to the estimated costs to maintain the required quality.

Also, with regard to mechanisms for transfer of resources, more details should be established with the financial agent of national scope, following the Hydrographic Basin Cleanup Program (PRODES), in operation since 2001.

PRODES, also known as the "treated sewage purchase program", is an initiative that does not finance works or equipment but pays for the results achieved, i.e., effectively treated sewage. It consists of the granting of financial stimulus, in the form of payment for the treated sewage, to Sanitation Service Providers that invest in the implementation, expansion and operation of Sewage Treatment Stations (STSs), provided that the conditions established in the contract are met. In ten years (from 2001 to 2011), about 46,5 million euros were reversed in 55 STSs, which were built (investments to be implemented by service providers of about 167 million euros).

Even with elaborate policies and programs like these, the formulation and implementation of water policy in Brazil is highly fragmented, due to governance gaps and related coordination challenges. The OECD (2015) points out some of these shortcomings:

- There are many drafted water resources plans, but they are often poorly coordinated and ineffective in practice because of the lack of both implementation and funding capacity. As a result, the plans are nothing more than "paper tigers" or promises to be fulfilled by others. The National Water Resources Plan is too broad to be able to set specific priorities and cannot connect to a development strategy or coordinate decision-making.
- The mismatch between administrative boundaries (municipal, state and federal) and hydrological boundaries (river basin committees) leads to a "double matrix", which needs to be reconciled, and which is exacerbated by double dominance³ and shared jurisdiction over state / federal rivers.
- Isolated approaches among ministries related to water issues hamper political coherence at different levels. In particular, poor coordination between water resources policies, land use, sanitation, the environment and economic development is detrimental to water policy. The fact that municipalities are generally absent from participatory structures is an aggravating factor.
- The National Water Resources Council has not fully played its role in intersectoral coordination. The level of representation of the ministries is not enough, which weakens their influence on the decision-making process and strategic orientations. Due to the technical nature of its work, the Council has often acted as a chamber of record, rather than serving as a consultative platform of weight to guide public action.

³ By virtue of the Federal Constitution of 1988, the waters have double dominion: they belong to the federal states, when they have their springs and estuary comprised in the areas of these entities; and belong to the Union, when their courses exceed the limits of these units or national borders.

- When they exist, charges for water use are low, as are the collected amounts. The funds raised accumulate without visible use, which is discouraging for the users charged and for the river basin committees in general. Revenues from hydropower are shared by various organizations and are not usually specifically targeted to the water sector. Prioritization in accordance with federal, state, and basin needs is low.
- Although ANA has a high level of qualification, with engineers and qualified and competent personnel, this is not always the case in deliberative bodies and public administrations at different levels of government. State capacities are generally more limited in terms of personnel, funding, participation and political commitment, and the country is in a tangle of many river basin committees resulting in low implementation.
- The image of "water abundance" in Brazil generates an awareness gap, which impairs the capacity of responsible authorities to deal with pressing water issues. Politicians and citizens are aware of the consequences of "bad" water management but tend to consider the issue from a purely sectoral point of view.
- Quality and access to hydrological, economic, and financial data and information vary among states in Brazil, as well as their ability to monitor water use and enforce policies. ANA's key role must be complemented by that of other stakeholders, to develop federal water managers, and additional tools to fuel a national decision support system.

The situation of public participation is also widely problematic. Public involvement in the activities of restoration has been characterised by the verticalisation of decision-making power in activities of local governance processes, which has at least two causes: one is the established elitism of the Brazilian electoral system, which has profound reflexes on any attempt to broaden public participation a persistent asymmetry in the opportunities to contribute to the decision-making process (Ioris, 2009, p.17).

Regarding river restoration projects, although efforts exist, they sometimes suffer from the same problems to continue. Information on them is also scarce and difficult to access. Another problem, once again the example of the city of São Paulo and its river restoration project (Tietê Project), is the paradoxical relation of those responsible for the project: Sabesp (company responsible for project) is one of the main responsible for pollution of waters. The Agência Pública⁴ discovered that in several parts of the capital the company captures the sewage of the houses and plays it untreated in the rivers, streams and dams that make up the Alto Tietê

⁴ non-profit investigative journalism agency in Brazil.

Basin, whose perimeter coincides with the limits of the Metropolitan Region of São Paulo - where 20,2 million people live. The practice constitutes an environmental crime according to Article 208 of the State Constitution.

The company was denounced by the Public Prosecutor's Office in October 2012, since its creation, directly and uninterruptedly, to a greater or lesser extent, to launch in the bodies of water the sanitary sewage *in natura* collected in the cities of the Metropolitan Region of São Paulo, that is, without any type of treatment, provoking water pollution not only in the catchment area of Alto Tietê where the municipalities are inserted, but also in the Billings and Guarapiranga reservoirs.

4.1.4. Case Studies in Brazil

Although, as previously presented, the situation of rivers in the country and the governance format still needs to overcome some gaps and strengthen the integration and coordination of its policies, there are in Brazil the ingredients for a future-proof water governance system, including a huge potential in terms of innovation and qualification, a large and rich experience, and a push to move forward.

Proof of this are the programs and projects for river restoration that happen in the country (Annex), which although difficult to access to information, exist and in some cases (such as the cities of Curitiba, Belo Horizonte and Capibaribe, explored in the sequence) are examples of success that can serve as a school for other cities and water courses in the country.

Social analysts have shown that there is a strong causal relationship between better governance and better development outcomes such as higher per capita incomes, lower infant mortality and higher literacy (Kaufmann et al., 1999).

And this is what is shown about the cities mentioned above according to the Brazilian Institute of Geography and Statistics (IBGE), as shown the table below:

	Curitiba	Belo Horizonte	Recife
Per capita income	US\$ 12.941,05	US\$ 10.123,93	US\$ 8.613,38
Literacy	97,6%	97,6%	97,1%
Infant mortality	7,7/1000	9,9/1000	11,9/1000

a) Viva Barigui Project, Curitiba, PR

Curitiba, the capital of the State of Paraná, occupies a 432,17km² area, housing a population comprising 1.828.092 inhabitants, with per capita income around US\$ 7.825. It's the seventh most populous city in Brazil. The city represents a GDP equivalent to 2,37 billion dollars.

Located 900 m above the sea level, Curitiba has a temperate climate, and its average temperatures range between 21°C in summer and 13°C in winter. Its average yearly precipitation is 1.413 mm.

According to the information found in the municipality's website, the Curitiba City Government encourages shared management, particularly by means of monthly Public Hearings which promote discussions between the community and the public power and encourage the city's population to effectively participate in the decision-making process.

The city's environmental policy is based on social participation, transversality and the construction of a sustainable society, which defines its own production, consumption and well-being standards, considering its culture, history and natural environment (CHAMBERS, 1987).

Other entities that act in the environmental question, whether independently or in partnership with the City Government, are Non-Governmental Organizations (NGOs), Universities and Social Organizations.

The introduction of the environmental dimension in the urban planning and policies currently in force, or which may be adopted, respecting each body's institutional competencies and mission, is based on the following strategies, which are considered priorities for its urban sustainability: i) reorganization of the urban territory, considering drainage basins as basic planning units; ii) institutional strengthening, seeking the development of transversality in planning and environmental management processes; and iii) changes in production and consumption standards, reducing costs and waste.

In this approach the Viva Barigui Project emerged seeking to reverse degradation situations in the basin of Barigui River by means of measures that are aimed at preserving existing natural environments in the region and reordering illegal occupation areas by the river's margins.

The Barigui River Basin (a genuinely urban drainage basin) drains 279 km² and comprises the main land use and occupation types, occupies 1/3 of the municipality's area, and is inhabited by 1/3 of its population and 1/3 of its districts.

The Municipality's brochure says that the actions established in the program include the relocation of families that live in houses located at the margins, refilling of the Permanent Protection Area (APP)⁵ with native vegetation, supervision of the sewage system, and several

⁵ "Área de Preservação Permanente – APP: protected area, covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability and biodiversity, facilitating the genetic flow of fauna and flora, protecting the soil and ensuring the well-being of the populations human. " (Law 12.651/2012 - New Forest Code, Art. 3)

environmental education activities that aims to promote improvements to the basin's quality of water.

To achieve these objectives the actions were divided into infrastructure, supervision and environmental education. The infrastructure actions foresee the execution of works to avoid erosion, recovery and replenishment of the marginal vegetation, to implant and revitalize the conservation units in order to consolidate the Barigui Linear Park (this one with 45 kilometers of extension, with the objective to delimit materially the area of preservation, preventing the irregular occupation).

The supervision actions (through the Water Pollution Program/ Programa de Despoluição Hídrica) aim to reduce the volume of pollution throughout the Barigui Basin, through the correction of clandestine connections of domestic sewage that cause leaks and illegal release of industrial effluents, as well as the removal of solid waste. Specially trained teams assess the status of illegal sewage connections and check the conditions of collection and handling networks. Based on the results of this work, the City requires measures to correct both illegal and possible defects in the networks, seeking to reduce the high volumes of organic waste released daily in the Barigui Basin.

The environmental education actions consist of educational campaigns and assessments of the water quality of the Barigui River, made with the participation of the community, through the Programa Olho D'Água (Water Watch Program), in the monitoring of the quality of the rivers of the city, making efforts in groups of cleaning, community plantations and other actions that seek to encourage the population to preserve the water resources of the city. These actions also seek to identify and mobilize partners, promoting the formation of multipliers and the articulation among agents capable of intervening in the basin.

In addition to these actions there are still works of resettlement of the population located in the APP. Of the 1.159 families living on the banks of the river, 657 are in the preservation stretch and will be resettled elsewhere. The other 502 families will remain where they are and the areas will receive road infrastructure and sanitation.

The project will have double financing: around 20 million euros from the French Development Agency and another part (not informed) of its own resources and other sources of funding (Curitiba 2018).

b) Manuelzão Project, Belo Horizonte, MG

Belo Horizonte, the capital of the State of Minas Gerais, occupies a 331,4km² area, housing a population comprising 2.523.794 inhabitants, with GDP per capita around US\$ 8.758.

Located 852 m above the sea level, Belo Horizonte has a temperate climate, and its average temperatures range between 27°C in summer and 17°C in winter. Its average yearly precipitation is 1.602 mm.

The Manuelzão Project was created in January 1997 on the initiative of professors of the Faculty of Medicine of the Federal University of Minas Gerais. The rise of Manuelzão is linked to the activities of the Internship in Collective Health, compulsory discipline of the curriculum of the Medicine course in which students spend three months in municipalities of the interior of Minas Gerais developing activities of preventive and social medicine. The history of the experiences of these teachers and students revealed that it was not enough, from period to period, to medicate the population. More than that, it was necessary to fight against the causes of disease. Based on the perception that health should not only be a medical issue, the work horizon of the Manuelzão Project was outlined: to fight for improvements in environmental conditions to promote quality of life, breaking with the predominantly welfare practice (UFMG, 2018).

The watershed of Das Velhas river was chosen as the focus of action. The basin of the Rio das Velhas (São Francisco basin) has an annual average flow of 631 m³/s, a drainage area of 27.867 km², an extension of 761 km and an average width of 38 m and is now home to 4,5 million inhabitants. Das Velhas River is essential for the water supply of the metropolitan area of Belo Horizonte and the other municipalities that are part of the Basin.

Based on the realization that it was necessary to revitalize the Das Velhas River, the Manuelzão Project proposed, and the Government of the State of Minas Gerais assumed the commitment with Goal 2010 (Meta 2010): to sail, fish and swim in the Das Velhas River, metropolitan region of Belo Horizonte, until 2010. For that, it will be necessary to fit the quality of this section into class II⁶.

The guiding concepts of the project are: sustainability, diversity, democracy and care (Machado, 2008, 43). Diversity is the recognition and respect for the difference of the other that by design includes not just another human being, but all species. Democracy enables actions towards the solution of the conflicts caused by the environmental crisis and the contradictions of society itself (ibid.). The methodology used sought to articulate educational

⁶ "Class II: Waters which may be used:

a) to the supply for human consumption, after conventional treatment; b) protection of aquatic communities; c) recreation of primary contact, such as swimming, water skiing and diving, according to CONAMA Resolution No. 274 of 2000; d) irrigation of vegetables, fruit trees and parks, gardens, sports and leisure fields, with which the public may come into direct contact; and e) aquaculture and fishing activity." (Resolution No. 357/05 of the National Environment Council)

action, social mobilization, politics and scientific research in the Basin in order to favor the return of the aquatic ecosystem closer to the natural conditions.

In order to reach the objectives of Goal 2010 and using the guiding concepts, the fundamental actions for the recovery of the entire basin involved works of sanitation, socio-environmental education, mobilization and social participation; such as the elimination of sewage systems in rainwater networks and streams, the implementation and expansion of Sewage Treatment Plants (STP) and the recovery of natural vegetation and riparian forests (Manuelzão, UFMG).

The actions of environmental education and social engagement were so successful that several agreements with public agencies were carried out and / or supported, such as the Belo Horizonte Environmental Recovery Plan (2002) elaborated and strengthened due to the strong opposition to the practice of channeling rivers and streams provides for urban drainage measures that avoid plumbing. The Belo Horizonte Municipal Sanitation Plan (2001) defined the 99 elementary basins of the Das Velhas River Basin as planning units, incorporating the sustainable drainage concept established and established by the Project. The performance of the Project in the Das Velhas River Hydrographic Basin Committee enabled the Basin Master Plan to define the Goal 2010 as the hydro-environmental recovery action axis.

The cost for the implementation of Goal 2010 was budgeted at 444,5 million euros, with 222,2 million euros guaranteed and destined by COPASA (Minas Gerais Sanitation Company) and prefectures of Belo Horizonte, Contagem, Itabirito and others (Machado, 2008, p. 49).

The Goal 2010 was 60% successful. It is possible to swim safely in Santo Hipólito, in the region of Curvelo, in the middle course. In this region is celebrated the miracle of fish multiplication and the resurrection of the river. NUVELHAS/Manuelzão/UFMG biomonitoring data, which has been carried out for more than ten years, prove that fish previously absent are now reaching the Metropolitan Region of Belo Horizonte. To continue the project and not let it be forgotten, the Goal 2014 was then planned to complement and complete the initial actions and objectives of the project.

According to information found on the website of the project, Goal 2014 excludes in a peremptory way the construction of dams in the channel of the Das Velhas River and Cipó River basin and its main goal is the conquest of a society with a new vision of the world that is civilizatorily superior, ecosystemically adequate to the needs of all species, truly democratic and just, abolishing boundaries and prejudices. The waters and the fish are fulfilling the strategic role of guides and inspirers of a transformation of the mentality.

c) *Parque Capibaribe, Recife, PE*

Recife, the capital of the State of Pernambuco, occupies a 218 km² area, housing a population comprising 1.633.697 inhabitants, with GDP per capita around US\$ 8.609.

Located in the coast (only 10 m above the sea level), Recife has a humid tropical climate, and its average temperatures range between 30°C in summer and 22°C in winter. Its average yearly precipitation is 2.263 mm.

In response to Recife's startling growth at the end of the last century, and the problems of verticalization and limited mobility, neighbourhood residents' associations have played an increasingly important role in pressing for new city legislation. An important example is the implementation of a regulation that is still in use limiting the building height to six floors in areas close to the river, and a maximum of 20 floors across the rest of the urban fabric in 12 of the city's districts (Monteiro & Carvalho, 2016, p. 99).

In 2012, problems such as development projects that were detrimental to the city's landscape or involved the demolition of historic buildings, led to a population discontent and a discussion forum called Urban Rights by activists in the city. This movement held various occupations at strategic points in the city that brought a great shared lesson that Recife's future could no longer be the result of a top-down process of decision and development - citizens also wanted to participate in shaping the future of the city.

With this in mind, in 2013 the new mayor of the city began his mandate assuming a different vision for the future of the city, involving the transdisciplinary research group INCITI (University of Pernambuco - UFPE) to study the options of urban and environmental recovery of the river Capibaribe.

The project aims to rescue the watershed as the backbone of the city through areas of leisure, rest and well-being. It provides for a system of integrated parks along 15km on each bank of the Capibaribe river, totalling 30km of transformations (12 catwalks, 45km of cycle path and 51km of park streets) on the edges of the main watercourse of the city. The goal is that the city becomes a City-Park until 2037.

Although it is not a restoration project that includes measures to improve the quality of the river's waters (its water quality index - IQA varies from regular to poor, according to the last Monitoring Report of the Waters of the Atlantic Forest Basin conducted by SOS Mata Atlântica Foundation in 2017), which would be extremely important for a fairer and more balanced environment for all species, this fact, though, has not changed the community's appreciation of the river (see Rivière-Honegger et al., 2014) and may serve as a starting point for such future measures.

It is a great example of how the bottom-up approach to the conscious and engaged population brings quick responses to structural changes in how to plan the city and make decisions.

4.1.5. Results of the population's survey

As explained previously in Chapter 2, the hypothesis that based this work was that the key to effective changes in the treatment and perception of rivers and other watercourses was the engagement and interest of the population, as well as the understanding of the importance of this resource for all walks of life. With this, it became necessary to try to understand how the Brazilian population perceives its rivers and what degree of interest and importance it gives them.

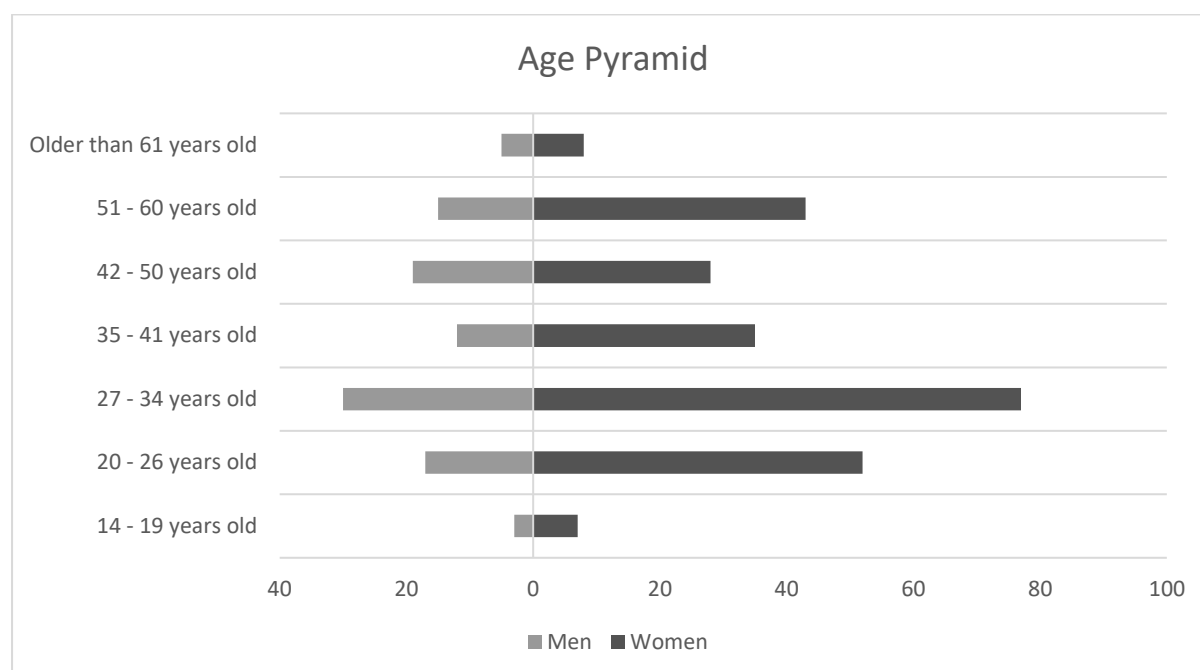
Another objective of the questionnaire is also to bring a moment of reflection on a subject that often goes unnoticed in the lives of people, who have often only become used to the everyday reality of polluted rivers – they are simply part of the reality, since a good part of the population did not know another reality of its rivers, especially the urban ones.

4.1.5.1. Socioeconomics

A brief socioeconomic analysis of the research results is important in order to understand what social extracts from society are involved and how best to correlate the responses of interest with the social and / or educational level of the attendants, in order to help elaborate strategies that are more appropriate to the public that one wants to reach with the proposition of solution to the problems encountered.

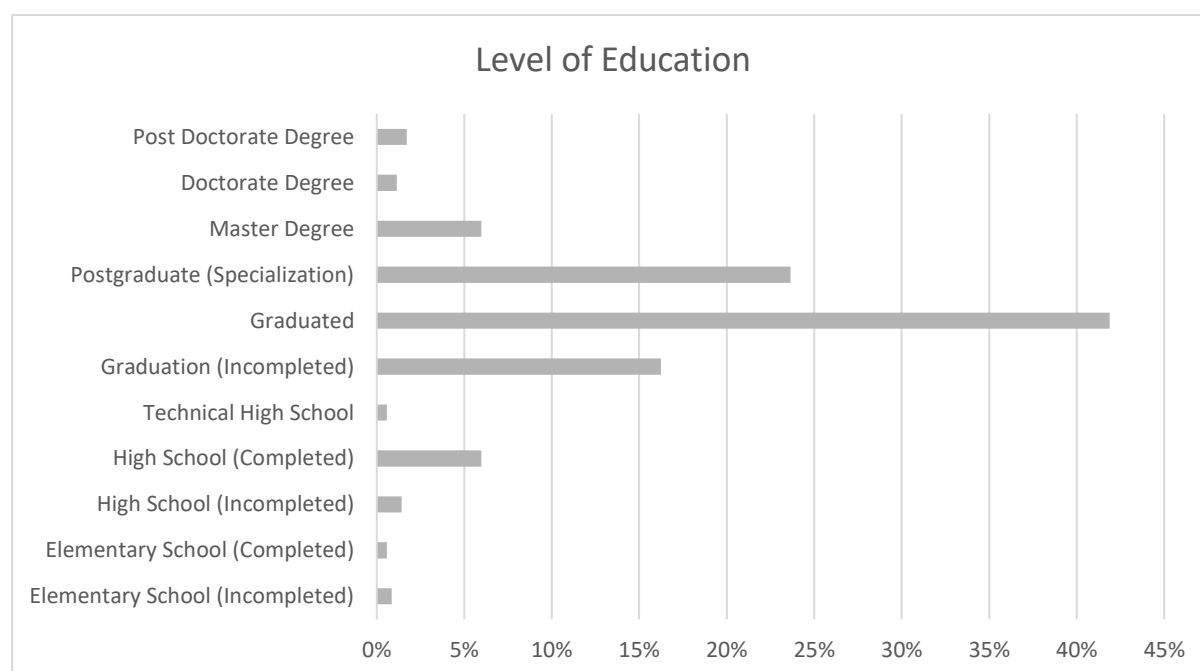
The graph below shows the age pyramid of the survey attendants and in the sequence the graphs of instruction level (Graphic 4-2) and average family income (Graphic 4-3) are presented.

Graphic 4-1 Age Pyramid of the attendants of the public survey.

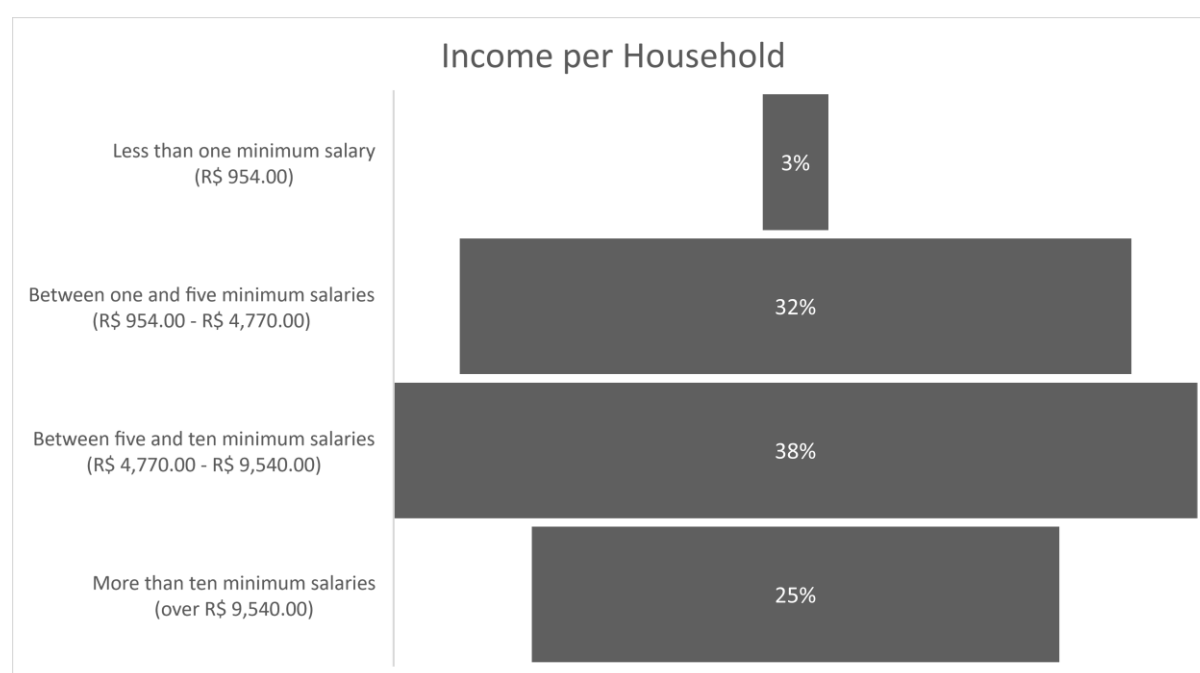


Source: The author, 2018.

Graphic 4-2 Level of education of the attendants of the public survey.



Source: The author, 2018.

Graphic 4-3 Family income of the attendants of the public survey.

*Minimum salary = R\$ 954,00 = ~ 219,42 €

Source: The author, 2018.

According to the Center for Social Policies of the Getulio Vargas Foundation (FGV), economic classes are defined based on per capita family income and are divided into A, B, C, D and E, being:

Economic Class	Inferior Limit	Superior Limit
Class E	R\$ 0	R\$ 1.254
Class D	R\$ 1.255	R\$ 2.004
Class C	R\$ 2.005	R\$ 8.640
Class B	R\$ 8.641	R\$ 11.261
Class A	R\$ 11.262	-

Source: Centro de Políticas Sociais da FGV. Available in: <http://cps.fgv.br/qual-faixa-de-renda-familiar-das-classes>. Access: 28 May 2018.

Therefore, the survey encompassed the majority of the population in classes C, D and E (75% of the total) and only a quarter of the attendants representing classes A and B, in order to satisfactorily reflect the Brazilian reality, which has 80% of its population represented in classes C, D and E⁷.

⁷ According to the survey "Synthesis of Social Indicators 2017 - SIS 2017" conducted by IBGE.

4.1.5.2. *General analysis*

The questionnaire begins with simple questions to help the participant to internally search for information about the existence and conditions of watercourses in the region of their residence. In this part, it was found that in 75% of the cases the participants considered a river as the main water course and in second place, a dam (19%). From this beginning we can infer that "main" can be understood as "better known", "more spoken" or "primordial", considering the case of dams being the source of water supply, as indicated in subsequent questions: from the ones who selected the main water body as being a dam, 92% indicated its use as "water supply".

In any case, it is interesting to observe that at the same time people pointed the use as for water supply, they consider this water body as polluted (63%). This shows the poor understanding of the population in relation to basic issues, such as water supply once polluted rivers or dams could not be used to this matter.

Yet 20% of participants do not know if there is a specific use for the water body selected. Regarding the condition of water (polluted or clean), 83% consider the watercourse as polluted and point out the lack of interest of the government as the main reason for this situation; secondly (66%) the dumping of waste by the population is indicated as being the main cause of pollution.

Even though, from the 184 people who answered against population interest, almost 18% have declared not willing be part of the decision making about rivers and streams. Also, 100% from the ones who signalled "waste thrown by the population" replied "no" to be part of decision making.

Other reasons pointed freely by the attendants were: dumping of industrial and pesticides waste directly in the rivers, lack of sewage collection even in noble areas of the city and complete lack of basic sanitation system in some municipalities. Therefore, an institutional problem and not just land invasion. A few others also pointed that they believe there is a slow and small progress about the efforts by the government to expand the sewage collection network.

When asked about the importance of this water body on a scale of 1 to 5 (where 1 would be very important and 5 not important), 22% considered the watercourse to be indifferent to not important - 17% did not like even to be part of the decision-making process with regard to local waters.

Only 67% of the population believes that watercourses are important for both environment and public health (19% believes it is only about the environment and 11% it

is only about public health). It means that 22,79% of the attendants who considered the watercourses between “indifferent” and “not important” do not believe that the quality of the rivers and streams are connected to the living systems (humans or not), even so they replied that they would like to see measures of environmental education and projects for the restoration of those rivers and streams and to make part of the decision-making system.

This result shows that a portion of the population believes that the problem of river pollution is a problem of the government and that they as individuals have nothing to do or cannot do anything about it, posing as mere spectators of environmental degradation in their cities.

In order to understand whether this result (interest in watercourses and their conditions) correlated with the level of education and/or income, a mathematical regression was performed in order to understand whether these two themes have a significant correlation. To do so, values from 1 to 11 (being 1 for the lowest level and 11 to the highest) were assigned to the level of education and from 1 to 5 (being 1 for the lowest level and 5 to the highest) for the family income range in order to make feasible the calculation of the probability of significance (P-value) (Table 4-2).

Table 4-2 Summary of results for regression between Family Income and Level of Education.

SUMMARY OF THE RESULTS

<i>Estatística de regressão</i>								
R múltiplo	0,251574263							
R-Quadrado	0,06328961							
R-quadrado ajustado	0,060605626							
Erro padrão	0,895723187							
Observações	351							

ANOVA					
	<i>gl</i>	<i>SQ</i>	<i>MQ</i>	<i>F</i>	<i>F de significação</i>
Regressão	1	18,91908554	18,91909	23,58047276	1,81125E-06
Resíduo	349	280,0096894	0,80232		
Total	350	298,9287749			

	<i>Coefficientes</i>	<i>Erro padrão</i>	<i>Stat t</i>	<i>valor-P</i>	<i>95% inferiores</i>	<i>95% superiores</i>	<i>Inferior 95,0%</i>	<i>Superior 95,0%</i>
Interseção	3,322982127	0,22707818	14,63365	3,78589E-38	2,87636827	3,769595985	2,87636827	3,769595985
Level of Education	-0,15468795	0,031855192	-4,85597	1,81125E-06	-0,217340251	-0,09203565	-0,217340251	-0,09203565

Source: The author, 2018.

The value of multiple R shows the degree of correlation between two data ranging from -1 and 1, where -1 (negative) shows a negative correlation and 1 (positive) shows the perfect correlation; values close to 0 presents a weak correlation. The correlation of education and household income calculated by the Microsoft Excel tool *regression* shows

a weak correlation. This might seem surprising but given the high number of student participants and the current economic situation, it is a probable result.

The p-value is used to weigh the strength of the evidence (what the data are telling you about the population). So as the p-value is a number between 0 and 1 and it is interpreted in the following way:

- A low p-value (typically $\leq 0,05$) indicates strong evidence for the correlation;
- A high p-value ($> 0,05$) indicates weak evidence against the correlation;
- p-values very close to the cut-off (0,05) are considered to be marginal (could go either way).

Therefore, through this correlation it can be observed that the P-value is consistently low, presenting an extremely significant correlation. The reason for this is the high number of survey participants. This means, as already expected, that the relation between education level and average income are currently not intrinsically connected.

In the table below it is shown the correlation between the level of education and the willingness to participate in the process of decision-making of the rivers. The multiple R value reached was 0,0644, showing that the level of education is not correlated to the willingness to participate. Through the survey results it is possible to observe that the willingness varies a lot through low and high education people.

Table 4-3 Summary of results for regression between Level of Education and Willingness to Participate.

SUMMARY OF THE RESULTS								
<i>Estatística de regressão</i>								
R múltiplo	0,064431							
R-Quadrado	0,004151							
R-quadrado ajustado	0,001298							
Erro padrão	1,502026							
Observações	351							

ANOVA					
	<i>gl</i>	<i>SQ</i>	<i>MQ</i>	<i>F</i>	<i>F de significação</i>
Regressão	1	3,282255	3,282255	1,454846554	0,228568899
Resíduo	349	787,373	2,256083		
Total	350	790,6553			

	<i>Coefficientes</i>	<i>Erro padrão</i>	<i>Stat t</i>	<i>valor-P</i>	<i>95% inferiores</i>	<i>95% superiores</i>	<i>Inferior 95,0%</i>	<i>Superior 95,0%</i>
Intersection	7,265873	0,259124	28,04012	2,08501E-91	6,756231615	7,775514417	6,756231615	7,775514417
Willingness to Participate in Decision Making	-0,25198	0,208913	-1,20617	0,228568899	-0,66287016	0,158901906	-0,66287016	0,158901906

Source: The author, 2018.

Table 4-4 Willingness to participate of decision-making process regarding to river restoration.

Level of Education*	Willing to be part of decision-making (%)	Not willing to be part of decision-making (%)
Low	75	25
Medium	84	16
High	75	25
*Low: people who's the level of education goes from incomplete elementary school to incomplete high school; Medium: people who's the level of education goes from complete high school and incomplete graduation; High: people who's the level of education goes from graduated to post-doctorate.		

Source: The author, 2018.

Another important result from this survey concerns to the awareness about the sewage collection where not everyone has the clear information regard their own households being connected or not to the public sewage collection network. Adding this to the analysis of the believes of the ones who consider the rivers as not important or do not will to participate in the decision-making process neither care about the destination of their own waste water. We can infer that the Brazilian population just cares about the rivers and other waterbodies after the improvement measures are implemented and they can indeed profit from it, but without taking part in the changes to reach this goal. At the same time, some who do not consider waterbodies in any importance level stated the willingness to participate. This inconsistent result shows that even when people do not personally care about the changing, the idea of an improved environment appeals to the population. Anyway, there is a clear mismatch of the improvement processes, where it is only possible to reach the goal through their personal engagement in the subject.

4.2. EU

4.2.1. Legislation

This chapter presents, in summary, the main laws of environment and water protection in the European context.

For European countries the legislation about water protection comes from a single document: Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, also as known as The Water Framework Directive (WFD). It is a directive which commits European Union member states to achieve good qualitative and quantitative status of all water bodies and it is a framework in the sense that it prescribes steps to reach the common goal rather than adopting the more traditional limit value approach.

The document aims for the ecological and chemical good status of surface water according to: biological quality (fish, benthic invertebrates, aquatic flora);

hydromorphological quality such as river bank structure, river continuity or substrate of the river bed, and physical-chemical quality such as temperature, oxygenation and nutrient conditions

Chemical quality that refers to environmental quality standards for river basin specific pollutants. These standards specify maximum concentrations for specific water pollutants. If even one such concentration is exceeded, the water body will not be classed as having a “good ecological status”.

The Directive requires Member States to establish river basin districts and for each of these a river basin management plan. The Directive envisages a cyclical process where river basin management plans are prepared, implemented and reviewed every six years. There are four distinct elements to the river basin planning cycle: characterisation and assessment of impacts on river basin districts; environmental monitoring; the setting of environmental objectives; and the design and implementation of the programme of measures needed to achieve them (JNCC, 2010).

The Article 1 of this directive establishes: “The purpose of this Directive is to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;

(b) promotes sustainable water use based on a long-term protection of available water resources;

(c) aims at enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances;

(d) ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and

(e) contributes to mitigating the effects of floods and droughts (...).”

It can be concluded that this approach sees river restoration as a concept of sustainable development, considering not only the intrinsic value of healthy rivers but also the benefits for humans by ecosystem services such as flood protection, drinking water and human health.

Article 3 regulates the cross-border development of river basin districts with their management plans, one of the fundamental principles of European water governance. Article 14 is dedicated to Public information and consultation:

1. Member States shall encourage the active involvement of all interested parties in the implementation of this Directive, in particular in the production, review and updating of the river basin management plans. Member States shall ensure that, for each river basin district, they publish and make available for comments to the public, including users:

(a) a timetable and work programme for the production of the plan, including a statement of the consultation measures to be taken, at least three years before the beginning of the period to which the plan refers;

(b) an interim overview of the significant water management issues identified in the river basin, at least two years before the beginning of the period to which the plan refers;

(c) draft copies of the river basin management plan, at least one year before the beginning of the period to which the plan refers.

It must be noticed, that even though the EU intends to foster public participation as a part of governance, it shall merely be encouraged, which makes it non-mandatory when certain reasons are seen as a hindrance. Further Articles deal with mandatory reporting, water quality objectives and hints for implementation.

4.2.2. Situation of the rivers

As written earlier, the rivers in Europe's industrialised countries suffered heavily from several pressures. From the medieval age on, agriculture required flat and fertile areas that would not be flooded in the case of rainfall events. Especially in mountain regions, flat areas could mostly be found next to rivers and streams. Since rivers in natural condition quickly and regularly cover their floodplains with water, it was necessary to separate the fields from the river and to protect them by embanking the rivers. Simultaneously, the demands of fishery and boating resulted in the first construction of channels and artificially straightened riverbeds (Brown et al., 2018, p. 191f). Further man-made obstructions, mostly weirs, became the dominant artificial structural component of European rivers (ibid.). These served to obtain the hydraulic energy that was needed for mills. Further demand for channelled rivers with heavily reduced floodplains came up with increased settlement in towns and cities, which are often located at rivers. The demand for areas on which houses could be constructed required effective flood protection, so the taming of the rivers by dams and solid materials increased (Schneider, 2010, p.187). The discharge of waste water into the rivers grew, as sanitation systems and water treatment did not exist yet. The anthropogenic impacts on rivers in Europe

reached their maximum during the phase of industrialisation: new requirements for electricity production, shipping, industrially used water, cleaning of chemical facilities etc. left the rivers in deplorable situations: richness of species, diversity of habitats, riparian wetlands, meandering of river branches and further aspects of ecological quality were reduced to a minimum (Schneider, 2010, p.190). Strong usage of synthetic fertilizers in agriculture resulted (and still does today) in high diffuse pollution with nitrogen and phosphate by surface run-off, seepage and erosion.

While the usages of the river that initially caused the anthropogenic modifications often faded, for example in the case of water mills, the rivers remained in poor condition and were widely considered as disturbances and dangers to human well-being, providing nothing but disposal of toxic materials and the risk of floods. Cultural usage or appreciation of their ecosystem services rarely occurred.

A change of mind regarding the desired form of rivers only took place after the 1980's, when the knowledge on the capacity of flood plains for flood protection and appreciation for the ecological functions of rivers became popular. For example, in the case of the Rhine, integrated programs began to consider the benefits of connected floodplains by removal of dykes in 1996 (Schneider, 2010, p.200). Since such project happened only punctually, an area-wide trend towards restoration could not be observed. Especially where no imminent flood risk existed, restoration only took place occasionally.

Significant efforts for restoration and reduction of water pollution have been fostered by the Water Framework Directive, which enforces measures not only for practical reasons but also for the intrinsic values of healthy riverine ecosystems. The national authorities are supposed to achieve the objectives of the Water Framework Directive as described earlier. Szałkiewicz (2018) observed the status of river restoration in EU member states and confirmed the growing interest of society in improving the quality of the water bodies, which led to a strong increase in the number of completed restoration projects. However, recent evaluations of the Directive have shown that the objectives have not reached yet, even if positive outcomes cannot be denied. The key objective of the Directive is to achieve good status for all water bodies by 2015 (European Commission, 2012, p.3) and to create river basin management plans for all rivers in EU member states. By 2012, 124 out of expected 174 river basin management plans (RBMP) had been reported to the Commission, so a delay of the desired results could already be expected.

It is further reported that 47% of the EU surface waters did not reach the good ecological status by 2015. The number of surface water bodies in "good" state only increased by 10%. This has led to the Directive's effectiveness as a policy tool being questioned; with many

reviews further highlighting drawbacks and weaknesses (Voulvoulis, 2016, p. 359). The chemical quality of water bodies has significantly improved in the last 30 years, but the situation as regards these priority substances introduced by the WFD is below the objectives (European Commission, 2012, p.6). Many water bodies (almost 40%) are reported with unknown chemical condition, which shows that monitoring shows deficiencies. The WFD intercalibration exercise has compared Member States' methods for assessing ecological status to ensure that they are consistent with the WFD definitions ensuring comparability of results across Member States. Despite considerable progress, some countries show important gaps in the development and application of assessment methods (European Commission, 2012, p.7).

Another aspect of the water quality improvement is the performance of waste water purification systems. The latest reporting on the Urban Waste Water Treatment Directive (UWWTD) shows that waste water collecting systems were in place for 99% of the total polluting load of EU-15 and for 65% of the total generated load of EU-12 (ibid.). This proves that new member states are lagging behind in this regard. Higher treatment levels could mostly be found in the old member states, while the newer member states could only provide basic levels of purification as a result of low investment capacities.

4.2.3. Restoration and water governance

In some countries of the European Union, governance and participative planning approaches in the water sector have a long tradition, beginning far before the implementation of the Water Framework Directive. For example, in 1996, when German authorities planned the construction of polders in the Rhine basin under consideration of ecologic requirements for ecosystem restoration, they included diverse interests: the representatives of water resource management, agriculture, forestry and recreation were consulted and actively participating in the process (Schneider, 2010, p. 200), which marked one of the first large projects for governance in river restoration. With the Water Framework Directive, multi-level governance was firstly introduced as a formal part of environmental policy. This includes "EU, national and sub-national level, and prescribes new hydrologically based governance structures as well as non-state actor participation (Söderberg, 2016, p.90).

Another new approach is the focus for water management by putting the protection of the aquatic environment and ecological targets at the heart of an integrated water management approach at the river basin scale. For this purpose, national legal frameworks and water management administration are supposed to be altered in order to cohere with the EU policy goals. Even though the EU Commission sees significant progress, this process widely has not taken place yet in most countries (European Commission, 2012, p.8). Instead of integrating

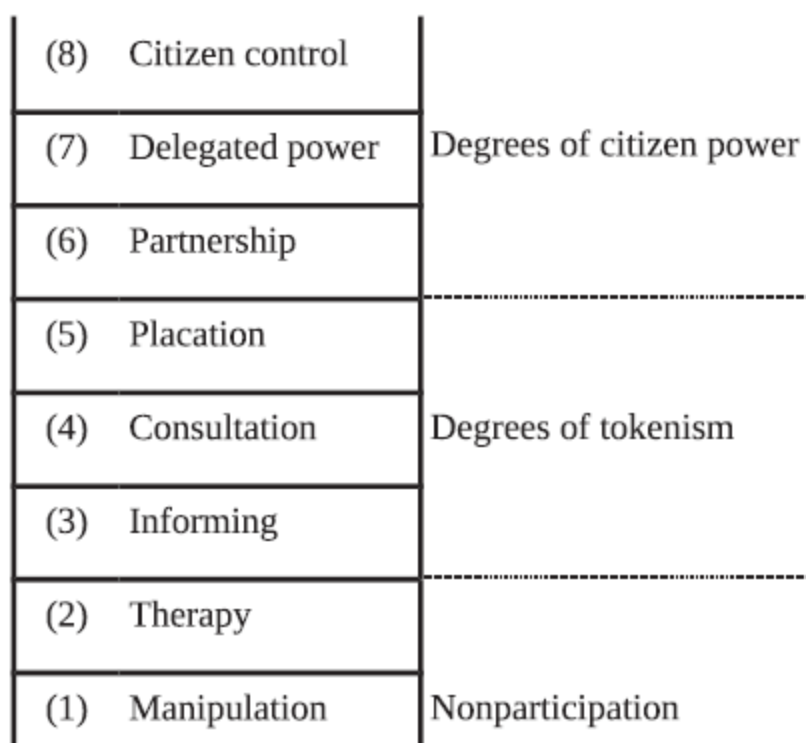
the Water Framework requirements into their laws and procedures, member states seem have included them as additional goals. Szałkiewicz (2018, p.1) revealed that 56% of 119 surveyed European river restoration projects from the recent years have been implemented by dedicated entities and stakeholders, not as part of any structured, larger-scale river restoration policy. This indicates that most European countries do not follow integrated plans for river restoration.

Furthermore, member states are expected to include measures addressing all water uses into their river basin management plans (RBMP), which must be coherent between other river basin management plans and parallel spatial and environmental planning tools. This integrated approach is supposed to be reflected in a governance setting (ibid.). The EU stated that this has been implemented to varying degrees. In many cases, dedicated administrative units were made responsible for the implementation of WFD measures. These units are often not clearly linked with the regular water management and the planners on basin level. “The result creates overlapping approaches and in some cases decisions and actions that are not compatible with WFD objectives” (ibid.). Anyway, cross border cooperations can be found, which consist mostly of joint problem diagnosis and joint decisions on measures that are reaching over the border. For example, Sweden transformed their administrative structure on water: it is now ecosystem based, which means that a governance administration manages water following the natural movement of water instead of municipal borders. Hence, Sweden is divided into five Water Districts. In each district, one County Administrative Board is assigned to govern as Water District Authority. The government appoints a Water Delegation for each district, which makes the most important decisions about planning objectives (Söderberg, 2016, p.93).

Planning of land use, agriculture, urban development, hydropower, navigation, flood protection, all have potentially important impacts on water resources (European Commission, 2012, p.12). Therefore, water governance in the entire river basin enable stakeholders to interact with all sectors and allows to develop a framework for integrated activities. The WFD requires to merge all water policy objectives into one policy that addresses ecology but also economic activities that rely on water. This mostly goes for agriculture, which is a significant pressure (causing point and diffuse pollution by organic matters, nutrients, pesticides and hydromorphological interventions) and therefore urgently needs to be included into planning. Even though 90% of all RBMP (River Basin Management Plan) that have been reported to the EU so far name agriculture as major pressure, barely any reaction on this pressure could be seen and no association of farmers was named as contributor to the plan (ibid.).

Besides economic stakeholders, the WFD gives special attention to participation of citizens. However, it must be noted that active involvement (which goes far beyond information and consultation) is not a statutory requirement during the implementation of the WFD as it should only be “encouraged” (Art. 14(1) WFD). Active involvement means that citizens act as stakeholders actively participating in the planning process, taking part in discussions, co-creating solutions and ultimately deciding about measures. The WFD names different degrees of involvement: “Information supply is the first level, which refers to providing access to the wider public to background information. The second level, consultation, relates to the public having the right to react to plans and proposals developed by the authorities” (Wright et al., 2017, p. 2270). Art. 14(1) of the Directive requires the planners to inform all non-state stakeholders, but consultation is only required during some parts of the process. Citizens are merely included by being given six months during the creation of certain documents, in which they can comment. Furthermore, access to background documents and information used for the development of the draft RBMP shall be given on request (ibid.). It is obvious that this procedure is far from being wide multi-level governance as active involvement means at least to include citizens into discussions.

Since the public participation as described here only applies for the creation of RBMP, it must not be ignored that participation on lower levels can be very different. The procedures for participation vary strongly between nations but even between local authorities, so that no complete image of participation can be provided here. Anyway, literature has shown that during the planning of restoration, public participation often only means that citizens are interviewed about their willingness to pay for certain measures, which is also a very limited approach. Respondents simply enter monetary values into a questionnaire, which on a scale of involvement can be interpreted as being a restricted form of consultation. (Wright et al., 2011, p. 2272). The figure below shows the scale on which public participation can potentially take place, proving that policy in the EU is generally still far from governance in its actual meaning.

Figure 4-3 The ladder of citizen participation.

Source: Arnstein, 1969, p.217 apud. Euler et al., 2018, p. 907.

The research survey by Szalkiewicz shows that less than half of the projects were designed and implemented with the active participation of local communities, which evidently led to conflicts between local stakeholders and implementing authorities (Szalkiewicz, 2018, p.10). On the other hand, it was found that high levels of participation can have positive impact on environmental management projects and resulted in longer-lasting results. Authorities often lack the resources to conduct participation on a broader scale, but also claim that further participation consumes too much time and might result in undesired results.

In order to organise stakeholder participation, Sweden has implemented water boards for information, deliberation and cooperation in planning processes. Those boards are not decision-making institutions but rather informal organisations: they provide a mean for dialogue with water stakeholders within a water district; are helpful in collecting local knowledge; and provide a forum for discussions of current and future water usage: (Söderberg, 2016, p.93). These boards are part of the new ecosystem-based structure, which includes new levels of authority outside the traditional top-down system from EU to local level. Today, different water management authorities exist on many interlinked levels, and the decisions are made on the metaregional level (ibid.). The implementation of measures is conducted by state and municipal authorities as well as by local stakeholders. While this system aims to cohere with EU goals, it is stated that slow progress, a lack of clear

responsibility due to unclear roles, imbalance of power and reluctance towards “orders from below” are hampering the planning processes.

It can be seen in Sweden that local commitment to water issues needs to be given legitimacy, because it can find good solutions, but it also has to be cultivated and developed. Responsibilities, for example for the Water Boards, need to be clear if they are supposed to contribute. Furthermore, most administrative organs cannot act without economic resources, so that increased governance requires increased spending.

Regarding the funding of projects, Szalkiewicz (2018, p.7) found that from 2011 to 2015, 65% of all projects were co-funded by the EU, while before 2000, no project received EU support. This shows another impact of the Water Framework Directive. As 22,2% of all costs were funded by Non-governmental-organisations, it could be seen that associations and groups of enthusiasts play an important role in river restoration in Europe. Also, these groups must be included in planning processes in order to secure their knowledge and spending capacities. The analysis of the Programmes of Measures, which are elaborated as part of the WFD proceeding, showed a diverse range of funding measures and sources throughout the EU. A large part of the spending is done with public budget, but also private operators are expected to provide funds. European funds such as the Regional Development Fund or the Common Agriculture Policy can contribute, depending of the kind and purpose of the measure (ibid., p.11).

The projects analysed by Szalkiewicz had average costs of 310.000€ per hectare. Individually, the costs varied largely according to the objectives and the hydromorphologic situations (ibid., p.7). A big problem seems to be that monitoring is rarely integrated in the original budget, even if 80% of the projects intend to monitor its effect and cost efficiency.

An important aspect of EU-wide governance policy is the promotion of rational use of water through information campaigns but also through adequate water pricing and transparency about the costs of water (European Commission, 2012, p.10). Correct implementation of water pricing is fostered with subsidies from the Cohesion Fund and the Regional Development Fund. In this context, the Commission is carrying out an assessment of Member States' water pricing and cost recovery policies and requires action plans where deficiencies are detected. When a Member State chooses not to apply cost recovery to a specific water use activity, it needs to clearly explain what other measures are in place to ensure that WFD objectives are achieved (ibid.).

4.2.4. Case studies comparison

During this research, a comparative collection of case studies for river restoration and water management was made, and it was possible to observe, for example, that a restoration project takes, on average, between five and 25 years to complete, with several but not very different objectives (such as climate change, protection against floods, promotion of recreational use of waters and even for the simple aesthetic improvement of the city). Even with different goals, the trigger for these projects to go out of print and be successfully completed was, for the most part, one: the engagement of the population to pressure the governments of their municipalities, states and regions to take action for the restoration of rivers and effective water resources management – that is, those populations understand that components of a healthy environment, such as clean air and water, are considered public goods as they are non-rival and non-excludable (Emas, 2015).

As the table, which can be found in the annex, shows, 13 European case studies of restoration were found in various countries, including old and new member states. The selected projects took place or have been taking place in urban and peri-urban areas because it had been concluded from the literature research that governance and public participation are more relevant in those locations. The numbers of inhabitants in the surrounding area also vary between 60.000 inhabitants in the Mérida area in Spain and London with its 8,79 million inhabitants. The majority of the rivers had been in a channelled morphological form, where big amounts of concrete and technical interferences had been used to reduce the floodplains. Most of the projects carry the word ‘restoration’ or similar terms in their name, which was one of requirement for selection. However, it must be considered that the meaning of this term may differ strongly, as elaborated in chapter 3.2.

To guarantee that the measures of the projects are comparable, it was decided by the author that the projects must include added value in terms of ecosystem services by providing flood protection and recreation. These are river ecosystem services with very high importance for the population. The improvement of ecosystem services was mostly achieved by removal of concrete elements and dams, which enabled meandering, flood dynamics, sedimentation and growth of vegetation. This resulted in attractive spaces that can be used by the public.

Even if the recreation function, which includes clean water, vegetation, aesthetic views, access to the river and many more features, is a major reason for the population to support and demand restoration, this was not a sufficient reason to initiate the process in any of the case studies. In most cases, restoration was initiated as a reply to flood problems. Floods used to cause damages or bad hygiene when sewers were overloaded and spilling wastewater into the rivers. However, the majority of the implementing authorities considered the potential

to combine flood protection and recreation. Awareness of the diversity of ecosystem services that can be improved by restoration helped to create integrated plans that address multiple requirements. Not surprisingly, the attempt to combine as many dimensions of ecosystem services as possible was particularly strong in wealthy cities such as London or Munich. In those cities, restoration is conducted as part of urban development. Only in some East European cases, a clear focus on flood protection and disregard of social requirements hampered this integration. Furthermore, the less wealthy cities addressed the immediate pollution of the water by technical measures rather than natural floodplain restoration as the richer cities did. The different initial situations and lag of the newer EU member states must be considered here.

With regard to public participation, it could be seen that recent projects often included different attempts to involve public stakeholders and citizens. The extent of participation was growing proportionally to the importance of explicitly social objectives of the project. The extent of public participation, as described by the ladder in chapter 4.2.3 varied strongly. It can be stated for all projects that the *consultation* degree was not passed over in any project. Even the most successful and expensive project, conducted by wealthy cities such as Munich, consulted the population about their preferences, organised round tables to discuss openly, but did not let the public take final decisions. Technically, the consultations were however done on a high level, making use of eye-tracking and depth-interviews for the Isar restoration in Munich. It was reported in a Spanish project that participation was a key to obtain good social results, but the high number of groups and organisations involved caused problems in terms of delays and the number of aspects to consider. Consequently, it could be seen that citizens and their organisations were not named as actual stakeholders (except for Isar and Emscher), even when participation had taken place. The stakeholders that were named in the publications mostly only included water authorities, consultancies, associations of municipalities and NGOs as well as UNESCO. The author's comparison of case studies confirmed Szalkiewicz's research in this regard, and it also found that the costs of restoration were carried only by governmental funds. The degree of citizen's responsibility for river restoration is thus considered to be low throughout the European Union.

5. Discussion

5.1. Introducing the ecosystem services concept to Brazil

In the following chapter, it will be discussed how river restoration and water governance are different in Brazil and the EU, which will prepare the deduction of improvement proposals for the Brazilian nation. It is a key concept of this thesis to refer to the benefits of river restoration as ecosystem services. This is currently being done in the EU, where research on the use of the ecosystem service concept for sustainable environmental policy is taking place. The concept is being used increasingly to operationalize the objectives of the Water Framework Directive, for which it is highly appreciated by experts. However, the literature research in this thesis has shown several cases of incoherent use of the terminology. Different authors have extended and changed the terms, and authorities are implementing and interpreting them in different ways. The approach of Landers and Nahlik (2013, apud. Balvanera, 2016) to categorize ecosystem services as intermediate and final ecosystem services in order to separate those services that are actually being used from those who are merely provided, is only one possible way to deal with the fact that many ecosystem functions have no immediate value for humans. Other authors add the term ecosystem service flow to the terminology to show the relation of available and used services. More difficulties are generated by the use of term such as ecosystem service provision, capacity, potential and many more terms that can be seemingly used synonymously. It is certain that at this point, even if CICES (Common International Classification of Ecosystem Services) and others are looking to formalize it, no generally accepted or complete form of the ecosystem services concept exists, since it is still under development. This explains why in the Brazilian context, the concept has rarely been used so far. As long as it remains in an experimental state, the transfer to Brazil remains challenging, even though the usefulness is agreed on in Europe.

5.2. Comparison of the legislative basis

In the matter of the discussion and comparison between Brazilian and European laws here it is going to consider the 25 European countries members of the union as one single country. It is known that each country has the autonomy to decide the ways to reach the common goal but as all of them must respect the Water Framework Directive.

Through the comparison of both regulation structure and contents it is possible to cognize many similarities (

Table 5-1) such as the fact of “water is considered a not commercial product, but a heritage which must be protected, defended and treated as such”.

Table 5-1 Similarities between Brazilian and European environmental laws.

Subject	Law/Directive (BR)	Matching Citation (BR)	Law/Directive (EU)	Matching Citation (EU)
Preservation and Restoration	Federal Constitution of 1988, Art. 225, Paragraph 1	“To ensure the effectiveness of this right, it is incumbent upon the Public Power: I - To preserve and restore the essential ecological processes and to provide the ecological management of the species and ecosystems; (...) ”	Directive 2000/60/EC Art. 1	“(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems” (c) aims at enhanced protection and improvement of the aquatic environment”
	National Policy of Environment, Law nº 6.938/81, Art. 4	“(...) VI - the preservation and restoration of environmental resources with a view to their rational use and permanent availability, contributing to the maintenance of the ecological balance conducive to life (...)”	Treaty of the European Union Art. 191	“1. Union policy on the environment shall contribute to pursuit of the following objectives: — preserving, protecting and improving the quality of the environment, — protecting human health, — prudent and rational utilisation of natural resources, (...)”
Common good	Federal Constitution of 1988, Art. 225	“(...) an ecologically balanced environment, a common good used by the people and essential to a healthy quality of life (...)”	Directive 2000/60/EC Preamble	“Water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such.”
Socio-economy	National Policy of Environment, Law nº 6.938/81, Art. 2º	“(...) preserving, improving and recovering the environmental quality conducive to life, aiming to ensure, in the country, conditions for socio-economic development,	Treaty of the European Union, Art. 191	“(...) 3. In preparing its policy on the environment, the Union shall take account of: (...)— the economic and social development of the

Subject	Law/Directive (BR)	Matching Citation (BR)	Law/Directive (EU)	Matching Citation (EU)
		national security interests and protection of the dignity of human life (...)"		Union as a whole and the balanced development of its regions. (...)"
Responsibility	Federal Constitution of 1988, Art. 225	"(...) imposing on the Government and the community the duty to defend and preserve it (the environment) for present and future generations (...)"	Found in respective national legislature	
	National Policy of Environment, Law nº 6.938/81, Art. 2º	"(...) I - governmental action in maintaining the ecological balance, considering the environment as a public patrimony to be necessarily assured and protected, in view of the collective use; (...)"	Found in respective national legislature	
Education	National Policy of Environment, Law nº 6.938/81, Art. 2º	"(...) X - Environmental education at all levels of education, including community education, in order to enable it to participate actively in environmental protection (...)"	Green Paper on the European Dimension of Education, 1993	"increase the public awareness of the problems in this field, as well as possible solutions, and to lay the foundations for a fully informed and active participation of the individual in the protection of the environment and the prudent and rational use of natural resources."
Public participation	-	-	Directive 2000/60/EC Art. 14	"Member States shall encourage the active involvement of all interested parties in the implementation of this Directive, in

Subject	Law/Directive (BR)	Matching Citation (BR)	Law/Directive (EU)	Matching Citation (EU)
				particular in the production, review and updating of the river basin management plans. Member States shall ensure that, for each river basin district, they publish and make available for comments to the public: [several important planning documents]"

In this way, given the similarities in the definition and interpretation of the contents related to these regulations, the question remains as to the different applications of these laws / guidelines in a practical way in both realities. As will be shown in the following chapters, the European Union countries, as in other aspects, are more advanced in terms of development, implementation and monitoring of river restoration projects than the countries of the Global South, as the case of Brazil.

As explained by Marum (2002, apud Macedo, 2014) the development of Brazil, since its inception, occurred at the expense of the predatory exploitation of its natural resources. Practically, until the 1960s, the country experienced the phase of unregulated exploitation of the environment, where the conquest of new frontiers (agriculture, livestock and mining) was all that mattered in the relation between man and nature.

This vision changed, at least in terms of legislation, in 1972 with the drafting of the Stockholm Declaration, of which Brazil also was a signatory, and in its Principle I proclaims: "Man has a fundamental right to freedom, equality and adequate living conditions in an environment whose quality allows a life of dignity and well-being and has the sole responsibility of protecting and improving the environment for present and future generations. " It was the consecration of the environment as a fundamental right of the human being, essential for the dignity of human life and preserved not only for the present, but for the future inhabitants of the planet (Marum, 2002, p. 130, apud Macedo, 2014).

In this sense, it was considered that there is no possibility of realization of other fundamental rights without the right to a balanced environment, precisely because it is the right to life itself, that is, the right to water in adequate quantity and quality to supply

fundamental human needs, the right to breathe a healthy air, the right to have a control of substances that present risks to the quality of life, among other things to be safeguarded for the existence of life itself. The right to the environment is, from then on, the matrix of all other fundamental rights (Macedo, 2014).

The Stockholm Declaration was not important for the advancement of environmental issues in Brazil alone. The European Union, which until the post-war period, viewed the environment in a less than elementary way, introduced the subject in the Treaty of Rome in 1987 through the Single European Act, considering environmental protection as a component of Community policy (article 174, ex Article 130R) and the Treaty of Maastricht (Treaty on European Union, 1992) establishing the principle of sustainable development (preamble). To conclude, both Brazil and the EU ultimately positioned their legislative with a strong focus of environmental sustainability. The significance of the protection of water is equally expressed. However, the EU Water Framework Directive enforces practical national actions that result in cross-national water management plans and explicit goals for the water quality that must be achieved at a certain time. In Brazil, no direct procedures result from the legislation even if the objectives are more complete than those of the EU.

While both Brazil and the EU name the objective to educate the population about the environment in ways that promote sustainable and environmentally beneficial behaviours, there is a discrepancy regarding the promotion of public participation. The Water Framework Directive encourages participation and multi-level governance, even if the non-binding character of Article 14 is seen critically. National regulations and the general willingness of most EU member states to use participation have resulted in numerous projects where citizens were able to improve the process. Such clear intentions to involve the public, implemented in all levels of the legislatives, as seen in the EU, cannot be found in Brazil.

5.3. Similarities and differences of current challenges in river restoration

The case studies that were scrutinised during this research show the initial situations of rivers in the EU and Brazil. In order to develop proposals for the improvement of river restoration based on best practice of the EU, it is important to make sure that Brazil's current challenges can be tackled with those procedures. Possibly, the European approaches, which were developed for the specific situation of European rivers and in a European planning context, do not respond to the severe problems that Brazil is facing. Furthermore, successful projects may be unsuitable as source for inspiration when their transfer to Brazil is unrealistic due to a lack of (financial) resources.

At first glance, the current overall situation of Brazilian rivers can be compared with European ones several decades ago. The morphology of most big rivers in Brazil is strongly influenced by the requirements of settlements and agriculture, resulting in straightening and embankment with solid materials that do not allow flood dynamics and habitat development. In both locations, point and diffuse pollution with pesticides and fertilizers from agriculture causes high levels of eutrophication that cause exceed bloom of algae and other plants while endangering fish populations. While this still also represents the reality of most big European rivers, an additional problem can be found in Brazil's urban rivers: there, rivers and streams are frequently covered with concrete, on which settlement and infrastructure construction has taken place. This is a particular challenge because it disables the potential for restoration almost entirely. The removal of buildings and streets for the sake of restoration would be extremely expensive and likely unlawful when property is affected. In Europe, no such project has taken place so far. Dam removal for increased flood dynamics and riparian wetland development has been done in a number of cases outside of cities, despite the high costs. However, the density and costs of constructions next to urban rivers often leave no other choice than in-stream restoration. The possibilities for measures are limited by the top edge of the embankment, because until there, rivers are usually public property. Purchase of land in cities for restoration purposes outside of the embankment can almost never be afforded. Hence, Europe is more fortunate in this matter as streams are at least widely open, while Brazilian authorities often cannot access them. Where streams in Brazil are not covered, an increased usage of concrete parts for the entire river bed could be seen.

Another challenge that affects river restoration in Brazil is the water quality. Contrarily to Europe, where almost every household obtained access to a functional wastewater treatment system by the 1980's, the majority of Brazilian household does not have such access. Since the construction of the treatment facilities, the water quality in European rivers has been significantly improved. In Brazil, however, large amounts of untreated waste water are still being spilled into the rivers, often illegally. Even if the morphologic challenges are similar to the European ones to a certain degree, the water quality aspect generates priorities for interventions that are very different from the current objectives of European water policy. Sewer networks and purification plants are urgently needed before morphologic changes and habitat creation can be considered. Therefore, the advance that European river restoration currently has, must be respected and Brazil should not focus on the same objectives without carefully analysing the preconditions and intelligent use of resources.

5.4. Lessons from European water governance policies

5.4.1. Administrative structure and decision-making

At this point, it is possible to give suggestions to the Brazilian nation about modifications of the administration of water governance and its work. In order to respond to the finding that ecosystem and basin-based restoration is seen as a key factor for successful measures which consider the requirements of the river as a whole, it is suggested to re-invent the objectives of river restoration. The classic approaches such as species-based conservation paradigms are considered to lack resilience on a long-time horizon (Szalkiewicz, 2018, p.1) because they may conflict with the goals of settlement development and other human needs. This would be the case if Brazilian settlements that cover rivers had to be removed for the pure sake of nature protection. On the other hand, the development of societies has shown that increasing wealth comes along with demand for high-quality environment with recovery and leisure functions. These ecosystem services should be used to justify river restoration and high investments into it. The current plans in Brazil often focus exclusively on nature protection, which is no personal concern for many people. Therefore, goals must be made attractive and meaningful for the population, addressing goals that regard the ecosystem with all its functions, not only single species. It is beneficial that the survey showed a high level of willingness for dedication to restoration, even if the majority is unaware of the potential usefulness of healthy rivers.

To create such objectives, the process of decision making must be altered into a more inclusive governance process in which all beneficiaries of river ecosystem services can express their requirements and concerns. The coordination of these must be organised across public and private sectors to create a strong basis of persons that will support and invest into restoration. Decisions that only include nature protection cannot mobilise the required funds, whereas decisions based on economic activities that do not take into account requirements of water and rivers can drive unsustainable practices at the expense of the environment (European Commission, 2012, p.8). So far, a reform that leads to more cooperation has not been successfully implemented (Ioris, 2009).

Research about the European situation has shown that the tendency to favour more traditional practices of centralised decision-making can lead to significant barriers to multi-sectoral integrated governance (Voulvoulis, 2013, p.362). The Water Framework Directive demands for basin-based restoration and management plans, which has shown misfits with the institutional structure and administrative borders of the existing authorities and administrations. Many countries, unlike the exemplary case of Sweden that was analysed

earlier, show little willingness to change their traditional water management practices. It was demonstrated by researchers that centralised decision-making leads to missed opportunities for efficient policy implementation on the local level (ibid.), which is a result of less detailed knowledge and commitment from accountable stakeholders that are not personally concerned by the objectives. Therefore, it is recommended to Brazilian authorities to become aware of the benefits of basin-based plans and management before enforcing institutional changes. An attempt to implement river basin management in the Paraíba do Sul catchment was described as follows: “Despite various institutional changes promoted under the influence of the international theory, environmental problems are still not properly addressed by the river basin committee or the environmental regulators. Notwithstanding repeated claims of success by official publications or academic papers (published by those directly involved in the implementation of new regulation), the river basin remains in a seriously degraded condition” (Ioris, 2009, p.20).

These new basin-based approaches can only be conducted successfully when the authorities understand and support the advantages. Ultimately, water governance will have to take place beyond prior administrative borders and the creation of water boards where multiple sectors and stakeholders cooperate should be created following the Swedish example in chapter 4.2.3. So far, the Brazilian approaches are characterised by “a persistent reluctance to address the political dimension of water management among the members of the river basin committee. As a result, there is little recognition of the fact that the regulatory reforms have been systematically manipulated by the central government, via its water agency (ANA), and by the stronger economic groups, industry in particular.” (Ioris, 2009, p.20), as it was summarised with regard to the work of the Paraíba do Sul basin management.

Basin-based approaches are also necessary because it was found that the existing national plans are too broad and general to deduce objectives in particular areas. Objectives must be set locally in the basin context and they must be created in accordance with other planning and sectoral policy goals. The inclusion of a high number of stakeholders can make sure that all relevant requirements are considered.

5.4.2. Participation

The Water Framework Directive promotes public participation as another key element for the delivery of optimal decisions, which will be more acceptable and easier to implement (European Commission, 2012, p.9). It also points out that transparency on decision-making is particularly important when public opinions and consultation results are supposed to be integrated in decisions. It is recommended to make use of public

participation to levels that exceed the current procedures in Europe. For this purpose, consultation and information are not sufficient, but the population must be given privileges for taking part in decision-making.

This requires, however, that citizens possess sufficient information and knowledge to represent their interests. The survey showed that this is currently not the case since many people showed low degrees of information about the rivers in their environment and their potential benefits. A fundamental shortcoming in this matter is that documents about the condition and restoration potential of rivers are frequently not openly available. Generally, rivers seem to have little relevance because they are not actively used. At the same time, the reasons for the bad conditions that lead to the indifference are widely unknown and the responsibility of the population itself was frequently denied. This means that the problems resulting from waste and sewage in the water are not considered to be a societal phenomenon that could be fixed by the people. Instead, the responsibility is put on the government. Macedo (2014) argues that “The right to the environment is a right-duty *erga omnes*. It is a fundamental right of the citizen to a healthy environment, and the latter has an obligation to defend and preserve it”. It was found that the actual attitude of vast parts of the Brazilian population is quite the opposite, driven by indifference and the feeling to be powerless about the situation.

By higher education, at least with regard to a healthy environment, many problems that emerge from harmful every day behaviour could be avoided. Education, willingness to act and participation are thus able to improve the situation even when governmental investments into sewage treatment are not likely to bring results in the near future.

Not only the urban population but also river users and polluters should be involved. “Wright conducted an in-depth case study of participatory water management [...], which involved farmers in river basin planning to tackle diffuse nutrient pollution. The study finds that the participating farmers were able to contribute new information unavailable to planners based on their local knowledge” (Wright et al., 2011, p.2269). This participation also resulted in win-win solutions during river restoration and a change in attitudes could be achieved. Ultimately, farmers accepted the need for additional policy to address nutrient pollution whilst acknowledging their own responsibility (ibid.). Even though this research addresses urban rivers, the principle can be used in this context, too. Urban rivers usually have a number of users in the area of fishing, sports, transportation, tourism etc. All these can provide useful information and they often have personal interest in restoration (in different ways). When it is known to stakeholders, for example from tourism, that they can generate income in a healthy environment, it can be expected that they will join the process

or even invest into the implementation. Water managers would then, together with civil-societal groups, the business community, and agriculture, deliberate on concrete measures that would follow from the analysis provided by economic analysts. In this way, restoration becomes a matter of societal and economic relevance, providing it with the necessary weight in policy decisions.

The benefits of participation for decision-making are clear. However, evaluations of participative planning processes suggest that due to differences and gaps in participants' understanding of the matter, the process should always be guided and supported by experts, for example economists and water engineers. The judgement of experts might vary considerably from judgements made by the wider public (Collins et al., 2002). Consequently, participants might question the scientific basis, which generates the need for careful moderation and supervision.

5.4.3. Funding

While some of the above recommendations, especially participation, can be implemented by rather simple changes in the procedures of water authorities, the question of funding remains a difficult matter to approach. It could be seen that the most outstandingly successful restoration projects, such as the Emscher restoration, were implemented with huge public investments. As one of the core measures was the construction of an underground sewer system, these investments could not be avoided. The necessity for such investments in most Brazilian cities is equally large, and it must be acknowledged that even a reversal of harmful behaviours of the population will not lead to clean rivers as long as sewage cannot be treated. Those investments cannot be avoided if any attempt for ecological restoration should be made. However, with a change of attitude that can be achieved with governance, participation and ecological education, the investments can be justified and demanded by public pressure.

Until this is achieved, funding for restoration projects can be improved by moving the responsibility and duty of payment from supraregional and municipal households to dedicated public bodies, such as the proposed water boards or river basin managements, which will use their budget only for purposes concerning the river. In this way, the reluctance of existing authorities to spend money on matters like river restoration, which supposedly have low importance, can be avoided. Furthermore, it was reported by Ioris (2009) that the central government often follows own interests and favours the industry, so that the power on decisions and investments should not be in its hands. Also, cities usually set different priorities than environmental restoration, so that it is concluded here that the budget for restoration must be separated from municipal households.

As last recommendation with regard to money, it is proposed that water authorities set an adequate price on drinking water that is able to reduce overexploitation of the groundwater in the spring area. By higher prices, an incentive to save water is created, which is beneficial for nature in the extraction area but also with regard to a reduction of waste water. It is suggested to prohibit flat rates and shared water bills, in order to obtain transparency about the costs of certain behaviours and to increase public responsibility.

6. Conclusions

Rivers were and are an essential asset for the development of human kind whether about economic growth, health, security or culture. Rivers can provide – freely – plenty of ecosystem services such as food, energy, transportation, leisure, wellbeing and wealth as long as they are preserved, their water quality and environment kept healthy.

Even though it must be a priority objective of governments to preserve rivers, research has shown that river restoration is driven by society, and not necessarily by programs. This is good on the one hand, as stakeholders do not require national programmes to initiate projects, but bad on the other hand because the restoration should not rely only on the current mood of the population [...] (Szalkiewicz, 2018, p. 9).

Through the methodology used in this work, with the analysis of scientific articles and other sources of studies, the survey as well as a comparison of case studies, it was possible to conclude that before waiting for people to be interested in the condition of rivers, especially urban ones, it is necessary that they have knowledge about them and their benefits. People need to know what personal benefits they can get from a restored river. As examples, we can mention the economic benefit for landowners near the banks of these rivers, with the valuation of the surroundings and consequently the increase of the economic value of their areas (increase of the value of rent for example); or health benefits for a riverine population with decreasing disease rates caused by the proliferation of synanthropic species; and improvements in mobility within the city through the use of rivers as waterways; besides many other benefits in leisure and well-being. Certain economic activities, such as water-bound tourist activities even require restoration before they can exist.

These potentials can be transparently measured and used to legitimize decision making for restoration by using the ecosystem services concept. The clear lack of understanding and interest in most societal and economic sectors can be based on the missing use of the concept, as it is its principal idea to follow an integrated perspective.

Regarding the issue of governance, as pointed out in this paper, although in theory water governance in Brazil is carried out in a "decentralized" way through the concept of basin-based management, in practice there are several obstacles that do not let it happen in a satisfactory way. In fact, what exists is a vicious cycle between weak governance and a lack of knowledge of the population: the population lives in lethargy in relation to the surrounding environmental issues, such as river problems, and also does not receive the correct stimulus on the part of the government on the expected benefits of a restored environment and how their participation is important in achieving the best path and

improvement measures. Interestingly, the survey showed that this attitude cannot be related to the level of education or the household income. It is a general societal phenomenon, which might be most practicably addressed by governmental action in terms of initiatives for river restoration. Accordingly, future research will have to identify the right levers to overcome the lethargy of the society if a governmental initiative does not take place.

Another important factor observed is that although Brazil possesses a wide and complete range of laws, norms and directives regarding the maintenance and protection of its water resources and that it establishes that they are public interest goods, national security and the conditions to reach socioeconomic development (as in the WFD), the participation of civil society in the decision-making process is not defined as imperative or even primordial. This differs from the situation in the EU countries where the WFD demands that all persons involved in the relationship with the river be included in the decision-making on the river as set out in Article 14: “Member States shall encourage the active involvement of all interested parties in the implementation of this Directive, in particular in the production, review and updating of the river basin management plans.”.

It is known that, in general, there are public consultations on projects of great impact and / or repercussion, however, it is necessary to question the effectiveness of the dissemination of these consultations and even to explore new forms of dissemination, as in means of communication common to all the plots of society such as open television channels, radios and printed newspapers and not just for people previously selected or on the institution's website to lead the process of social communication.

As pointed out by Zingraff-Hamed et al (2017, p. 2) “urban river restorations are motivated by multiple ecological and societal drivers, especially (a) governmental interventions setting new requirements of legislations and laws, [...]; and (b) citizens’ increasing demands for a better quality of life, e.g., improvement of the recreational potential of the riverine area”. Also according to Zingraff-Hamed et al (2017, p. 7) the desire for a better quality of life for the citizens was the most declared motivation in France to start river restoration projects. If we compare this to the results of this work’s survey where 77% of the attendants have declared the rivers as very important and 82% stated themselves willing to be part of the decision-making process for restoration projects one can infer that Brazil is in the right direction to change its rivers reality. However, it is necessary to observe the efficiency of the Brazilian top-down approach that excludes, even if discretely, the participation of the population in the elaboration of environmental projects and decision-making. Non-governmental organizations could be key to this

mindset change, disseminating knowledge to the population, which is what initiates participatory behavior (in sequence there is the feeling about the cause, the perception of belonging, empowerment and organization for change and management).

The disclosure measures taken in the Manuelzão project are something to be studied and spread in a larger scale. Data must leave the academic environment and reach the civil society in a suitable approach to the public - the idea of a magazine being sold in drugstores and other non-conventional spaces where other sources of the same kind (magazines) do not deviate attention from it, is an innovative way to spread information on the project. One first step would be the mobilization of the academic society within the country to build the action plan, selecting the multidisciplinary team to take care of the editions and then look for private sponsoring or even help from NGOs for the publication and distributions. Aside from seeking partners that would be interested and open to give space to disclosure the work. In this way, step by step, it would be possible to increase population awareness, interest and engagement from the population opening doors for a real societal change.

Numerous approaches for the participation challenge could be identified in Europe and in literature about current issues with the implementation of the WFD. One possible approach to empowerment could be created following the suggestions of Wright et al. (2011, p. 2272) who proposes a "citizens' jury", which "emphasises informed discussion leading towards a consensus based on an argument about the public interest" (ibid.). The jury, which consists of 18 to 24 persons that are chosen through sampling in the local population, has the task to discuss a certain water policy question. After five days, during which they are debating and informed by experts, they present their recommendations to the politicians and authorities in charge. By this approach, the often-assumed lack of expertise of the population will not hamper the profoundness of the public opinion. Consequently, it will have more weight in decision-making.

Indeed, vulnerabilities such as strategic manipulation by those, who have the capacity to set the agenda, suppress arguments, and constrain access to the debate can happen (Wright et al., 2011, p. 2270) helping to lead a loss of interest by the citizens, which has been often feared in participation processes because "nonissues are at stake, because they choose to avoid the responsibilities that go with the right to have a say, or because they believe that the policies or plans at stake will never materialize anyway" (Roth et al., 2017, p.52).

As stated by Wantzen et al (2016, p. 9) "rivers are a factor of extreme importance for regulation and guarantee of a regulated environment. However, since the country has rich

and complete environmental legislation with well-defined plans, it is a signatory to international agreements, the question can be raised that the key to change is to make the population understand (or concepts of "learning from the river", which has been forgotten along with the notion of the population about what a healthy river is)".

Brazil has the elements pointed out by Wantzen et al (2016) with one of the most complete environmental legislations and numerous plans, which even follow the scientifically appreciated river basin approach. There is also the concept of decentralized management, through river basin committees (Tundisi, 2006) that would have as premise the integration of public power with the citizens in order to guarantee a transparent and participatory management. Although there are success stories, they are not majority and equally have low replication and dissemination rates. It can be deduced that this is due to the lethargic stage of a large part of the Brazilian population, especially the urban population, which with the economic advances of society stopped identifying itself with the rivers and sees them only as part of a (not always pleasant) everyday landscape. This, in addition to the history of colonization and development of the country, where mercantilist objectives always came first (as explained in item 6.1.2), the "culture" of river channelling prevailed, reinforcing in the subconscious of the population the idea that "corrections" and decisions regarding their futures are exclusively the responsibility of the public authorities.

It is therefore concluded, in addition to the necessity for implementation of participatory actions, that "unless analysis of development begins with the symptoms, environmental or economic instability, but with the cause, social injustice, then no development can be sustainable " - as indicated by Middleton and O'Keefe (2001, p.16).

In order to address this problem, it will be necessary to gain a complete overlook on the situation of river restoration success stories and cases where more action will be necessary. Therefore, the elaboration and dissemination of a complete database, which is easily accessible to the population and serving as a catalogue of measures and best practices, will be mandatory.

In case Brazil succeeds at addressing all the issues highlighted in this thesis, a positive perspective may become reality.

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Governance and the role of society for the restoration of rivers and streams in Brazil

Abstract

Pollution and degradation of urban rivers are recurring problems known in large cities and metropolises around the world, as well as in Brazil. The rapid and disorganized process of urbanization and lack of planning entails not only the problem itself but also the difficulty in solving it. Although river restoration practice has grown exponentially over the past few decades, little is known about these projects and whether they achieve the goals of improving the structure and function of streams and rivers. The objective of this work is to understand why some cities succeed in river restoration projects and others do not, with the premise that the engagement of the population would be the key to change this situation. Through the analysis and comparison of case studies in Europe and within Brazil, and through a survey that was conducted with the Brazilian population, it was possible to understand how the population feels about the rivers of their regions and what reasons lead them to mobilize and request changes from the government. In addition, the water policies of both locations and the structures of water governance were analysed in order to provide information on the framework in which the mentality of the society and its governors is shaped.

Key words: river restoration, ecosystem services, urban streams, water governance, societal drivers.

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Annexes

- I. Population Survey – Results
- II. Case Studies in Brazil
- III. Case Studies in EU

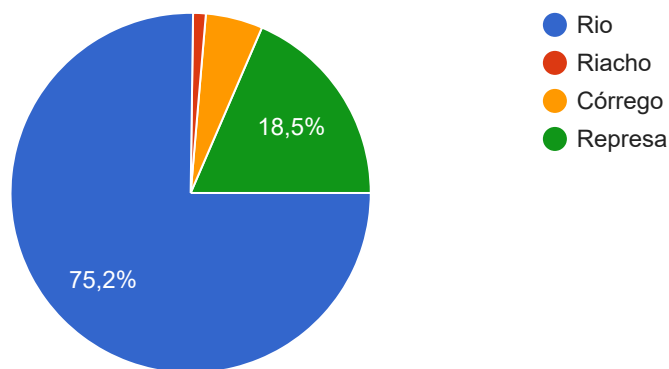
I. Population Survey – Results (in Portuguese)

Percepção da População quanto aos Cursos D'Água Urbanos

351 respostas

Em sua opinião, o principal curso d'água da sua cidade é:

351 respostas



Qual o nome deste curso d'água?

351 respostas

Tietê (38)

Rio Tietê (27)

Rio Tietê (18)

Tietê (17)

Sorocaba (15)

Tiete (13)

Cantareira (11)

Rio Tiete (7)

Rio Paraíba do Sul (7)

Billings (5)

Tamanduateí (5)

Tietê e Pinheiros (5)

Tamanduateí (5)

Guarapiranga (5)

Tamanduatei (4)

Não sei (4)

Rio tietê (4)

Rio Tiête (3)

Rio Atibaia (3)

Tiete (3)

Rio (3)

Rio Tietê e Rio pinheiros (2)

Não sei (2)

Tiête (2)

Ribeirão dos Meninos (2)

Represa Billings (2)

Represa de Taiaçupeba (2)

Cantareira (2)

Rio Paraíba do Sul (2)

Pinheiros e Tietê (2)

Córrego (2)

Alto Tietê (2)

Guarapiranga (2)

tietê (2)

rio Tietê (2)

Rio Tietê e Pinheiros (2)

Rio Ivai

Guarapiranga, Alto Tietê e Cantareira

Tejo

Bussocaba

Meia Ponte

Rio tietê

Rio Iguaçu

Represa Guarapiranga e Billings

tiete

Represa Parque da Cidade

RIO TIETÊ

Rio Uberabinha

Rio do peixe

Bussocaba

rio Tietê e o rio Pinheiros

Represa Guarapiranga

Sta Rita

Rio Ipiranga

Riacho grande

Represa billings

entre varios rios tietê e pinheiros...

Represa

Paraíba do Sul

Rio Tietê e rio Pinheiros

Rio das velhas

Tiquatira

rua atibaia

Tietê e pinheiros

tietê/pinheiros

represas billings e guarapiranga

Rio Guamá

Rio Cotia

Tietê/pinheiros

Paraibuna

Saldanha

represa guarapiranga, cantareira

Lake Ontario

Lago Bolonha

Rios Tietê e Pinheiros

Tucunduba

Curso d`agua

Rios pinheiros e tietê

Rios Tiete e Pinheiros

ipiranga

nao sei

Rio Igarapé Açu

Lençol freatico

Rio do Peixe

cantareira

Mairiporã

Quarapiranga

Guarapiranga, tietê e cantareira

Córrego Aricanduva

Billings e Guarapiranga

?

Caraparú

Rio Pinheiros

Rio Tamanduateí

Juqueri

Não sei :(

Represa Mariporã

Piracicaba

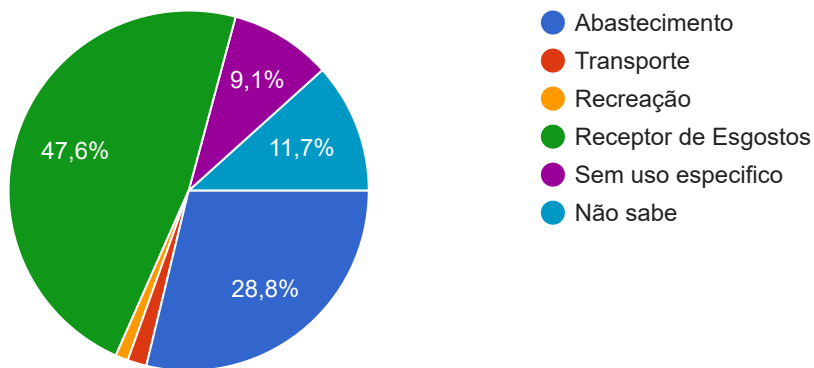
Tiete e Pinheiros

Tapajós

Outro (55)

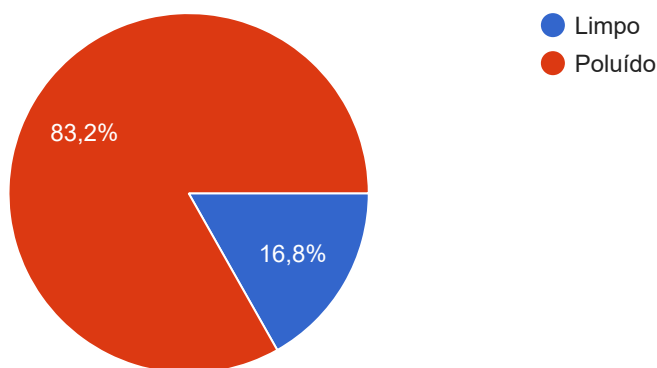
Qual o principal uso deste curso d'água?

351 respostas



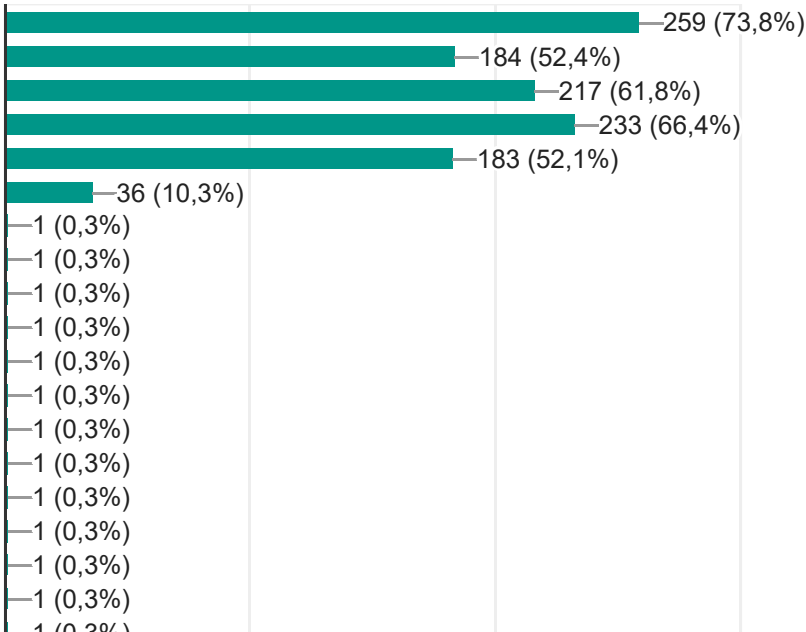
Você considera este curso d'água:

351 respostas



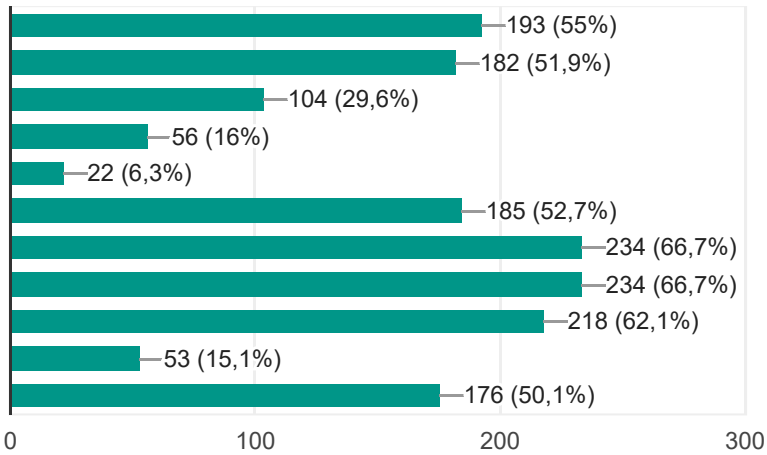
Em caso de "poluído", por que você acredita que ele se encontre assim? (mais de uma resposta possível)

351 respostas



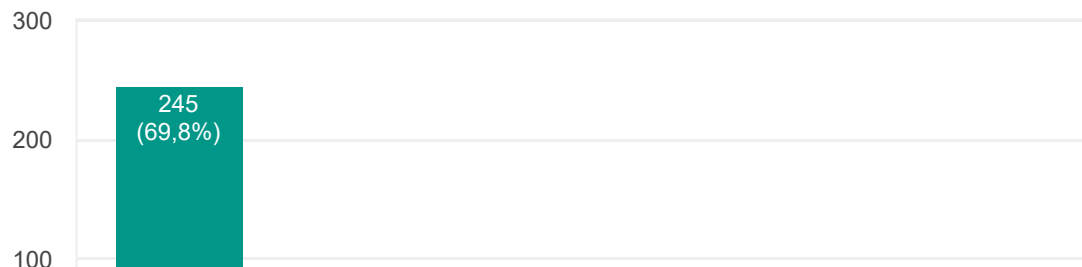
Qual a situação desse curso d'água? (mais de uma resposta possível)

351 respostas



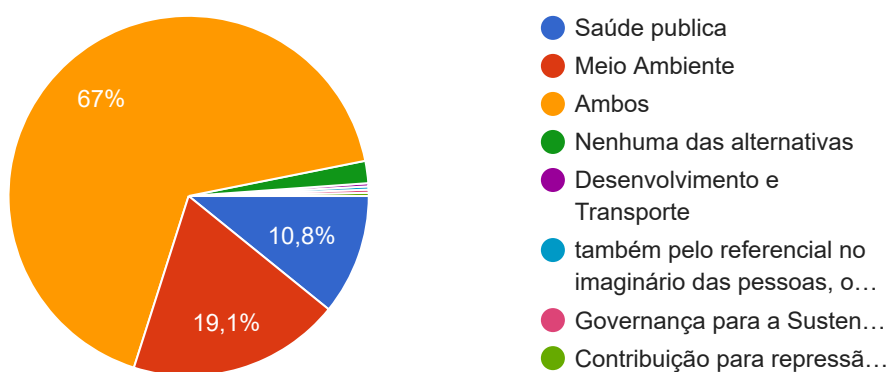
Você considera este curso d'água:

351 respostas



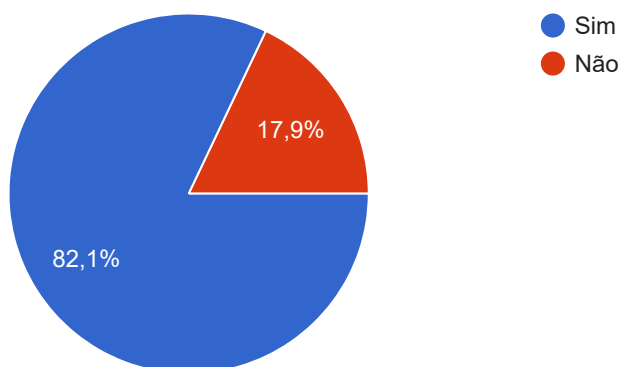
Em qual categoria de importância você aplica este curso d'água?

351 respostas



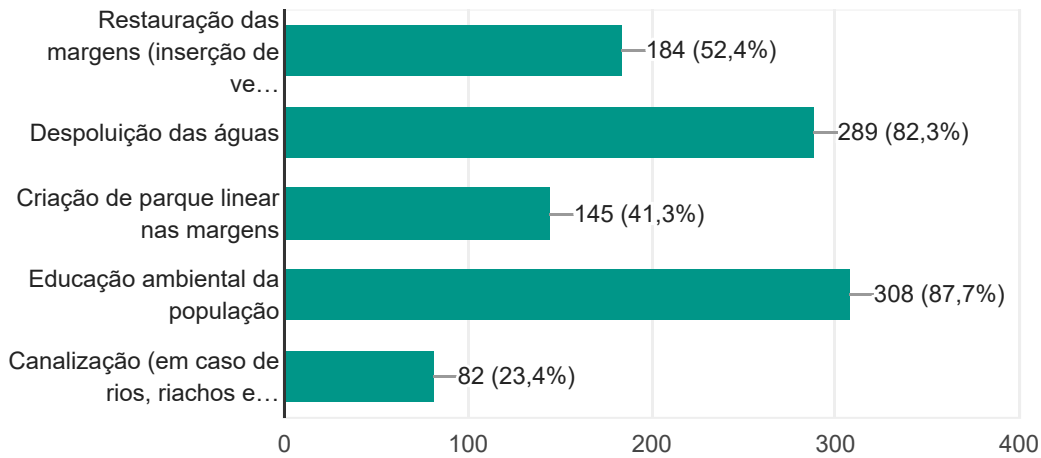
Você gostaria de fazer parte das tomadas de decisão em relação a este curso d'água?

351 respostas



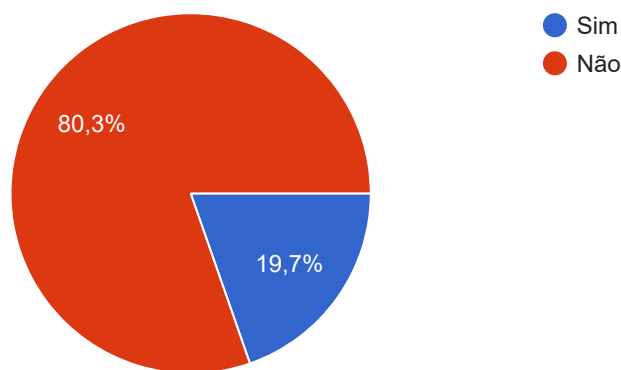
Quais medidas você gostaria que fossem tomadas em relação a este curso d'água? (mais de uma resposta possível)

351 respostas



Você possui conhecimento de algum projeto de melhoria das águas e/ou margens desse curso d'água?

351 respostas



Em caso positivo, qual?

67 respostas

Projeto Tietê (4)

Despoluição (2)

O governo tem um projeto para despoluição, mas não sei o nome e nem se ainda está ativo.

Governo tomou algumas medidas a alguns anos atrás como por exemplo inserção de vegetação.

Despoluição do rio Tietê

Rios e ruas

Desassoreamento

Projeto de despoluição do rio uberabinha

Projeto de Despoluição do Rio Tietê de responsabilidade do DAEE e o Projeto Rios e Ruas.

Houveram tentativas de despoluir o Rio Tietê e Pinheiros com químicos que a floculação dos poluentes e seriam retirados ao flutuar na superfície, mas não funcionou e no final só tinha mais química na composição já poluída do rio

Rios Des.cobertos (não é especificamente deste rio, mas é sobre a percepção dos rios em geral nos meios urbanos)

Programa Mananciais

Projeto de Recuperação das Apps, iniciativa privada promovido por usina Alcoeste

Projeto Tietê em SP

Projeto Tiê - <https://apublica.org/projeto-tiete/>

Dragagem

Despoluição

Jica

Limpeza do Rio

Tratamento adequado do esgoto e preservar a vegetação nas margens

Assoreamento das margens do Córrego e criação de piscinões em sua extremidade para evitar cheias.

Macrodrenagem de rios tributários

Alguns projetos já foram iniciados para despoluição dos rios, mas até o momento, nenhum vingou.

Obras de despoluição do Rio Paraibuna Juiz de Fora

Existe um movimento de algumas pessoas de recuperação das nascentes e mata ciliar

Despoluição dos rios

Projeto de Saneamento da Bacia do Tucunduba.

Projeto tietê

Projeto Tietê criado em 1992

Ações de limpeza do corpo das águas, plantio de árvores nas margens.

Educação ambiental

Programa de dessassoreamento e parte recuperada (Parque Ecológico do Tietê)

Despoluição do rio

Tietê

Parque ecológico do Tietê

A calha do rio foi aprofundada. As margens foram alargadas e concretadas. O governo fez um acordo para despoluição do rio com o Japão.

Aprofundamento/alargamento do leito do

Sanegram

arco tietê

Financiamento / investimento realizado por orgao do exterior (banco ou governo japones) realizado na em meados dos anos 90

Projeto Cantinho do Céu

Na Marginal Pinheiros tem um programa que planta árvore nas margens

Tentativa de despoluir pelo governo

Estação de tratamento e Abastecimento

Inúmeras ações governamentais onerosas e pouco ou nada efetivas

Tentativa de despoluição mal sucedida

Despoluição do Tietê, por exemplo, a qual é inútil, umas vez que não ataca as causas estruturais do problema, a saber, o despejo de esgoto no Rio, a concretização de suas margens (e a artificial rota do curso do rio), além do intenso fluxo de carros em suas margens.

Já foram gastos milhões em projetos de despoluição e nada avançou.

Canalizar e fechar o rio.

Projeto guardiões dos rios

Foi feito um canal de tratamento de esgoto Mauá, mas não tenho conhecimento do percentual que ele atinge.

IPH

Proposta de melhorias e zoneamento.

Tentativas de despoluicao dos correjos que abastecem o rio

<http://g1.globo.com/sp/mogi-das-cruzes-suzano/noticia/2015/06/projeto-preve-protecao-e-recuperacao-de-manancial-do-alto-tiete.html>

Desocupação das construções irregulares das margens

Projeto de despoluição do Tietê

Um projeto que infelizmente que mal iniciou e não foi adiante limpeza e assoramento do rio Tietê vitalização dos rio

Já vi projetos de parques, e outros de rios urbanos, mas não me lembro os nomes .

Há projetos de educação ambiental pela prefeitura e pela companhia de água local, além do projeto de saneamento básico para toda a extensão do rio, além de possuir parques próximos de pontos importantes do rio.

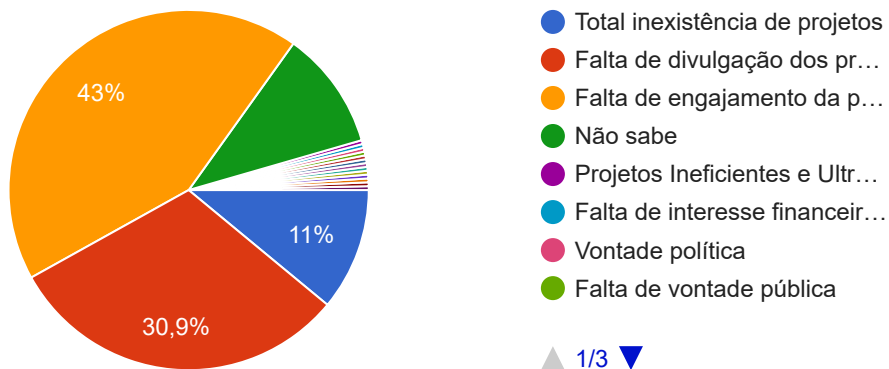
Projeto de recomposição das margens do Rio Tietê

pomar - JICA

Foi alargado e aprofundado o leito, e foi feita plantação de plantas nativas e

Em caso negativo, qual você acredita que seja o motivo?

291 respostas



Estrutura residencial

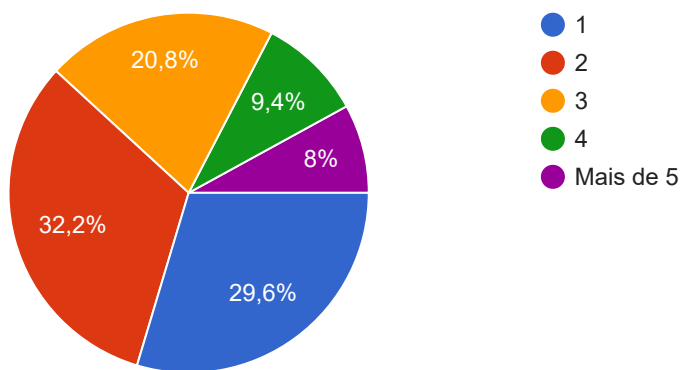
Qual seu tipo de residência?

351 respostas

 Casa independente

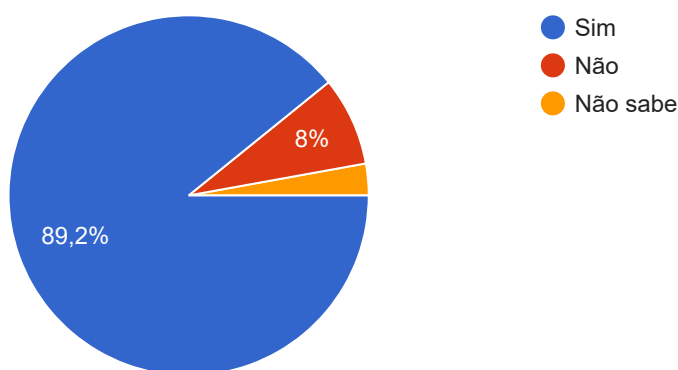
Quantos banheiros existem na casa?

351 respostas



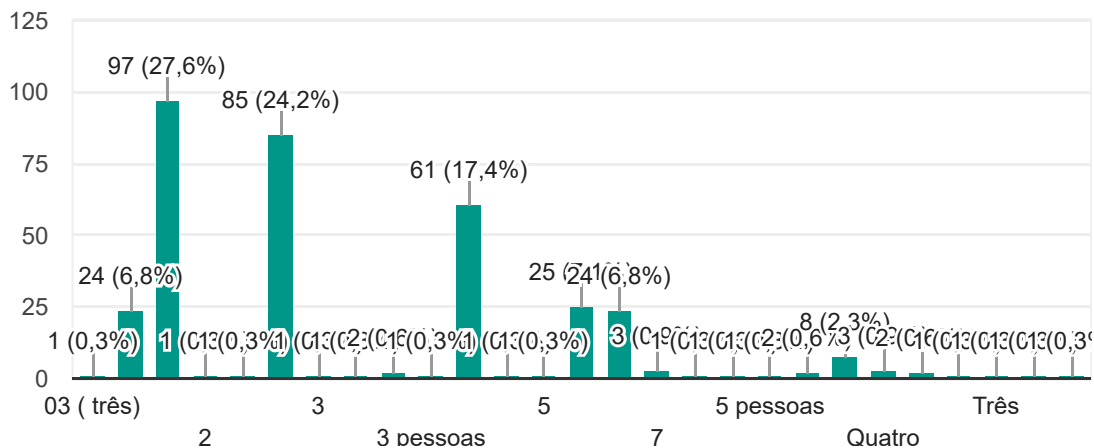
Você possui coleta de esgoto na sua residência (ligação com a rede publica de coleta)?

351 respostas



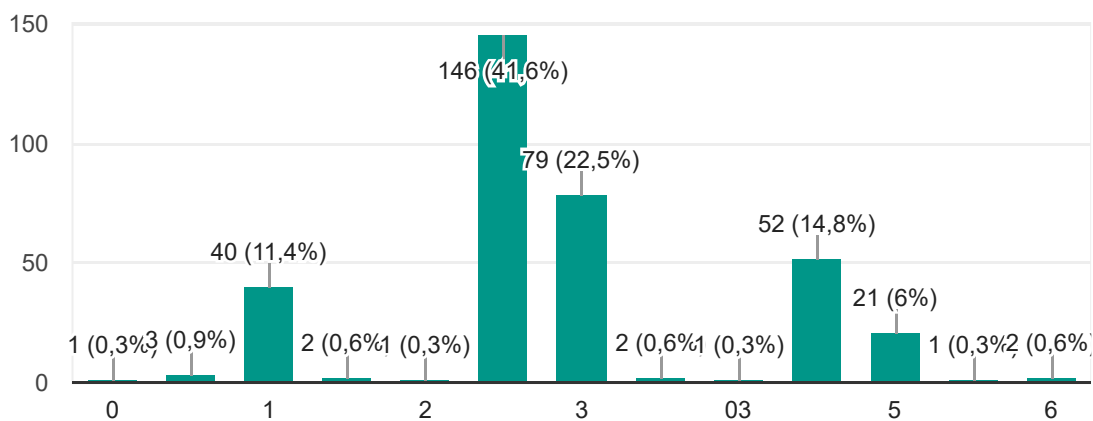
Contando com você, quantas pessoas vivem nesta residência?

351 respostas



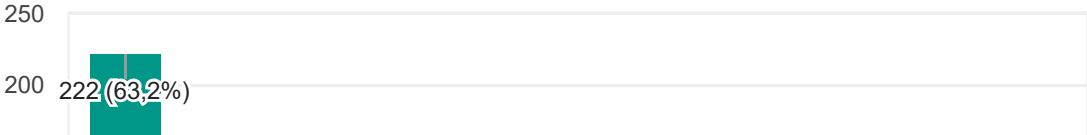
Quantos adultos (maiores de 18 anos)?

351 respostas



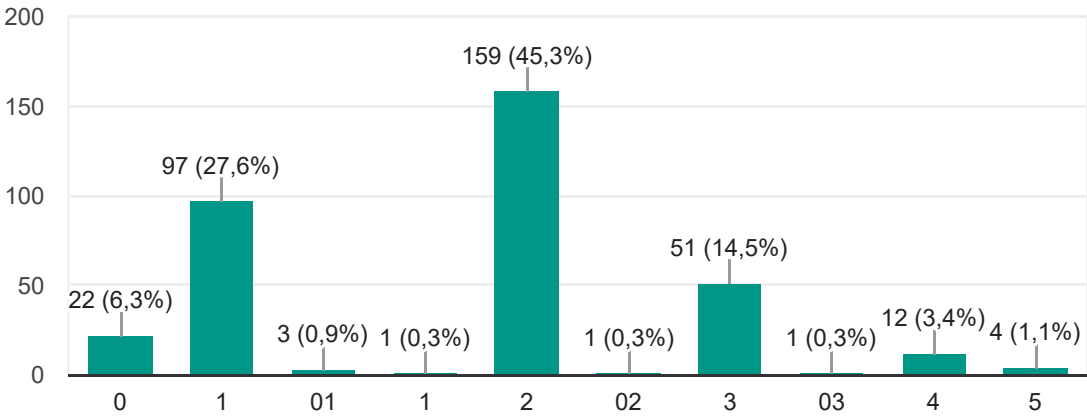
Quantas crianças (menores de 17 anos)?

351 respostas



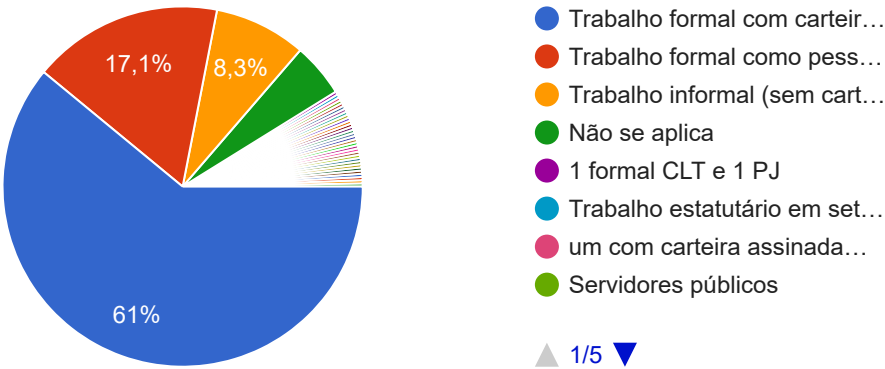
Atualmente, quantas pessoas estão empregadas?

351 respostas



Qual o tipo de contrato de trabalho?

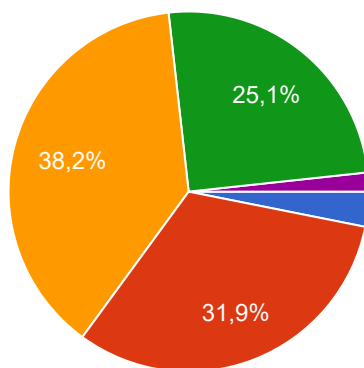
351 respostas



Qual a renda média mensal familiar (soma da renda de todos os que

trabalham)?

351 respostas

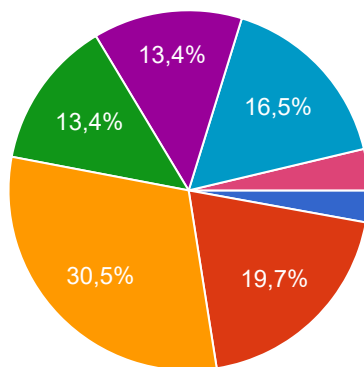


- Menos de um salário mínimo (R\$954,00)
- Entre um e cinco salários mínimos (R\$954,00 - R\$4.770,00)
- Entre cinco e dez salários mínimos (R\$4.770,00 - R\$9.540,00)
- Mais de dez salários mínimos (superior a R\$9.540,00)
- Não se aplica

Informações Gerais

Qual sua faixa etária?

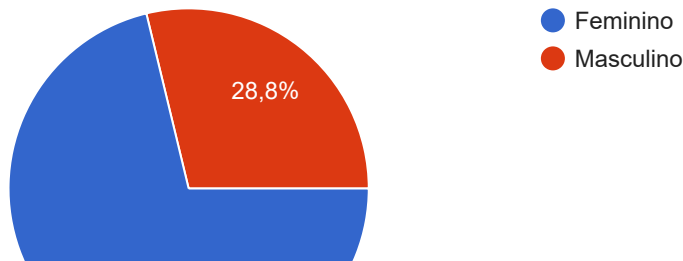
351 respostas



- 14 a 19 anos
- 20 a 26 anos
- 27 a 34 anos
- 35 a 41 anos
- 42 a 50 anos
- 51 a 60 anos
- Mais de 61 anos

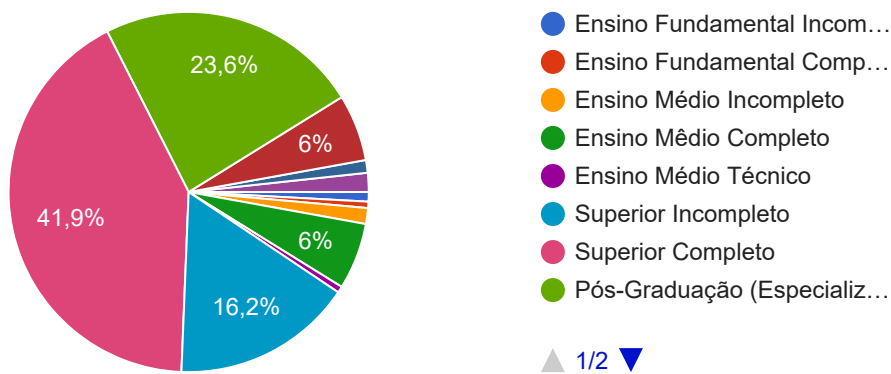
Sexo:

351 respostas



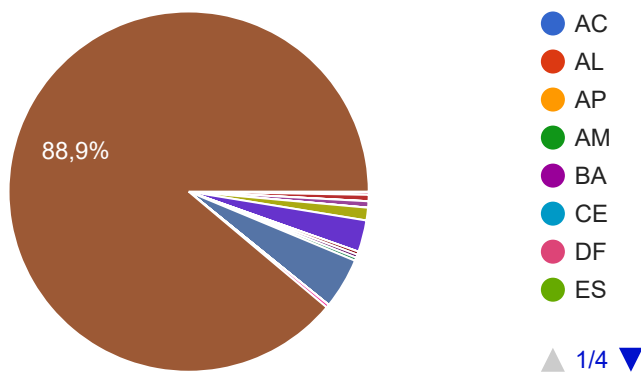
Qual seu grau de escolaridade?

351 respostas



Qual estado?

351 respostas



Qual cidade?

351 respostas

São Paulo (102)

São Paulo (45)

Sorocaba (15)

Mogi das Cruzes (13)

Sao Paulo (11)

Sao paulo (9)

São paulo (8)

Osasco (7)

Sao Paulo (7)

SP (7)

Santo André (6)

Sp (5)

Santo André (4)

são paulo (4)

Atibaia (4)

Barueri (3)

Guarulhos (3)

sao paulo (3)

Volta Redonda (3)

Goiânia (2)

Mogi das Cruzes (2)

Jundiaí (2)

São Bernardo do Campo (2)

Belém (2)

Cotia (2)

sp (2)

Mauá (2)

Volta Redonda (2)

Sao paulo (2)

Barra Mansa (2)

Belém (2)

Maringa

Lisboa

Duque de Caxias

Sbc

Sto André/ SP

Uberlandia

Guarulhos

Videira

Fernandópolis

Sao caetano do sul

Sao bernardo do campo

Suzano

Sao José dos Campos

Guaratinguetá

Lagoa Santa

Diadema

Atibaia

São Jose dos Campos

Pirapora do Bom Jesus

São Caetano do Sul

Juiz de Fora

Barueri

Terra Alta

Belem

São Pailo

Igarapé Açu

Marília - SP

São Paulo

MENDES

São Mateus

Santa Izabel do Pará

Caieiras

São Paulão

Aguas de Sao Pedro

Sao cetano do suul

Santarém

São Caetano do sul

Jundiai

Catanduva SP

Camaragibe

Teresina

São Bernardo do Campo

Maricá

Sorocaba

Araputanga

São Bernardo do Campo

Mogi Mirim

mogi das cruces

Volta Re4donda

Visconde do Rio Branco

Rio deJaneiro

Barra Mansa

Mauá

São Bernardo do campo

Osasco

Campinas

Mairiporã

Volta redonda

Santo andré

Rio de Janeiro

Primavera do Leste

Brasília

Francisco Morato SP

Embu-Guaçu

Rio de Janeiro

Castanhal

SÃO PAULO

Piracicaba

Obrigada por sua colaboração!



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II. Case Studies in Brazil

Table 0-1 Summary of case studies (river restoration) found in Brazil for this work.

Water Body Name	State	City	Rural or Urban Area (R/U)	Inhabitants	Project's Name	Extension	Short description of the Project	Project's Motivation	Stakeholders	Implemented/To be implemented Measures	Beginning Date	Finishing Date	Cost (US\$)	Paid by:
<i>Rio das Velhas</i> (das Velhas River)	MG	Belo Horizonte	U	5 873 841	<i>Projeto Manuelzão</i> (Manuelzão Project)	-	Promote the "return of the fish" to the das Velhas River	The understanding that human health is intimately and inextricably linked to the quality of life, that is, a healthy ecosystem.	University, Minas Gerais State Government, Belo Horizonte Municipal Government, civil society	- Implementation and expansion of Sewage Treatment Plants (STP); - Environmental Education	1997	2014	-	-
<i>Rio das Velhas</i> (das Velhas River)	MG	Ouro Preto	R / U	74 036	<i>Programa Revitaliza Rio das Velhas</i> (das Velhas River Revitalize Program)	-	-	-	State Government and Sanitation Company	- Engineering; - Sewage; - Recovery of springs; - Preparation of sanitation plan	-	-	50 millions	Resources raised by the cost of water use
<i>Rio Tietê</i> (Tietê River)	SP	São Paulo	U	12 106 920	<i>Projeto Tietê</i> (Tietê Project)	-	Expand and optimize the collection, transportation and sewage treatment system in the Metropolitan Region of São Paulo.	To contribute to the progressive revitalization of the Tietê River and its tributaries in the Alto Tietê Basin	State Government, Sanitation Company, Financing Institutions	- Installation of approximately 4,400 kilometers of trunk collectors, interceptors and sewage collection networks, pipelines buried with the function of collecting the generated sewage and transporting it to the treatment plants.	1992	-	2,8 billions	São Paulo' State, IBD
<i>Rio Pinheiros</i> (Pinheiros River)	SP	São Paulo	U	12 106 920	<i>Requalificação das Águas do Canal do Pinheiros</i> (Requalification of the Pinheiros Canal Waters)	141500 km ²	-	Contribute to the requalification of the waters of the Pinheiros Channel with urban-environmental gains, offering additional water supply with quality for the public supply of the metropolitan region.	Private Initiative, Municipal Government and civil society	Implementation and expansion of Sewage Treatment Stations	-	-	1,12 trillions	-
<i>Raia Olímpica da USP</i> (USP Olympic Lane)	SP	São Paulo	U	12 106 920	<i>Revitalização da Raia Olímpica da Cidade Universitária</i> (Revitalization of the University City Olympic Ray)	2 km	Integration of society with the university by replacing the wall with railings in order to symbolically	Symbolic integration of society with the university campus and embellishment of the area.	University, São Paulo Municipality and Private Institution	Demolition of the wall that separates the strip from the Marginal of the Pinheiros River and its replacement by	2017	2018	464 k	Private Institution (sponsoring)

Water Body Name	State	City	Rural or Urban Area (R/U)	Inhabitants	Project's Name	Extension	Short description of the Project	Project's Motivation	Stakeholders	Implemented/To be implemented Measures	Beginning Date	Finishing Date	Cost (US\$)	Paid by:
							share the campus with society.			electrofused railings.				
<i>Rio Capibaribe</i> (Capibaribe River)	PE	Recife	U	1 633 697	<i>Parque Capibaribe</i> (Capibaribe Park)	30 km	The project provides for a system of integrated parks along the two banks of the river Capibaribe in the city of Recife.	Mobilization and social organization against demolition of historical buildings and for greater participation of the population in the decision process of the future (urban and environmental) of the city.	Municipal government, education institution, civil society	- 12 catwalks; - 45km of cycle path; and - 51km of park streets	2013	-	-	-
<i>Rio Barigui</i> (Barigui River)	PR	Curitiba	U	1 893 997	<i>Projeto Viva Barigui</i> (Viva Barigui Project)	279	To reverse degradation situations in the basin by means of measures that are aimed at preserving existing natural environments in the region and reordering illegal occupation areas by the river's margins.	Lack or insufficient sewage system, population irregularly located at the margins, poor riparian zone	Municipal government, community and financial institution	- Relocation of families that live in houses located at the margins; - Refilling of the Permanent Protection Area with native vegetation,; - Supervision of the sewage system; and - Several environmental education activities.	2007	-	24 millions	Curitiba Municipality and French Development Agency
Involves 47 sub-basins	MG	Belo Horizonte	U	5 873 841	<i>DRENURBS - Programa de Recuperação Ambiental de Belo Horizonte</i> (Environmental Recovery Program of Belo Horizonte)	140 km	Reintegration of watercourses into the landscape and non-use of river channeling techniques. The project was designed to be implemented in successive phases, with an area of 51% of the total area of the	Integrated treatment of sanitary and environmental problems at the river basin level, adopting premises, such as the adoption of vegetated gutters; the implementation of parks and permanent preservation areas along the water courses; the	Municipal government	- Sewage collection - Margin stabilization - Riparian restoration - Riverside population relocation	2007	-	77,5 millions (first phase)	Belo Horizonte Municipality and BID

Water Body Name	State	City	Rural or Urban Area (R/U)	Inhabitants	Project's Name	Extension	Short description of the Project	Project's Motivation	Stakeholders	Implemented/To be implemented Measures	Beginning Date	Finishing Date	Cost (US\$)	Paid by:
							Municipality, involving 47 sub-basins, and comprising 45% of the total Municipality.	implementation of holding basins (reducing flood risks); among others.						
<i>Rios Iguaçu, Rio Botas and Rio Sarapuí</i> (Iguaçu River, Botas River and Sarapuí River)	RJ	Duque de Caxias, São João de Meriti, Nilópolis, Mesquita, Nova Iguaçu	U / R	2 500 000	<i>Projeto Iguaçu</i> (Iguaçu Project)	-	Flood control and environmental recovery of the Iguaçu, Botas and Sarapuí Rivers basins	Included in the Federal Government's Growth Acceleration Program	Federal Government, population of the affected municipalities	- Dredging of rivers and channels (56 km, 6 mio tons); - Establishment of 6 River Parks; - Sewage and solid waste collection; - Margin stabilization; - Replant riparian vegetation; - Relocation of 1700 (planned : 2500) families	2007	2011	5 millions	Federal Government through PAC (Growth Acceleration Program)
<i>Rio Mangaraí</i> (Mangaraí River)	ES	Santa Leopoldina	R	12 240	<i>Projeto Renaturalize</i> (Renaturalize Project)	-	Improve water quality, recreate habitats and increase river biodiversity, and reduce costs with aluminum sulphate in water treatment, dredging and drought and flood management.	British private initiative decided to start the project with the technique that was partly used in the Tamisa River restoration	Private initiative, local traditional communities	Use of eucalyptus trunks tied with steel cables at river points to reduce water velocity, allowing a greater infiltration into the water table and sediment freight.	-	-	109,5 k	Finep (Study and Project Finance) and Fapes (Foundation for Support to Research and Innovation of Espírito Santo)

Information marked "-" was not found until the closing date of this work.

Elaborated by the author, 2018.

III. Case Studies in EU

Table 0-2 Summary of case studies (river restoration) found in Europe for this work.

Water Body Name	City	Country	R/U/P *	Inhabitants	Project's Name	Short description of the Project	Project's Motivation	Beginning Date	Finishing Date	Implemented Measures	Stakeholders	Extension (km)	Cost (US\$)	Paid by:
Aarhus river	Aarhus	Denmark	U	270 834	Reopening the Aarhus river	<ul style="list-style-type: none"> - Enhance the aesthetics of the - Facilitate and promote recreational uses, - Adapt the city to climate change, - Protection against flooding - Reduce the frequency of sewage overflows originating from extreme rainfall events 	A political campaign and a change in the local administration	1989	2015	the establishment of two upstream lakes to reduce nitrogen and phosphorus flows into the Bay of Aarhus (Stahl Olafsson et al., 2015)/ the construction of new rainwater retention basins/ the implementation of an integrated real time control system to allow for coordinated operation of the sewer systems and wastewater treatment plants/ an early warning system for water quality in Lake Braband, Aarhus River and the harbour was incorporated (Basso, 2010).	Municipality of Aarhus, Aarhus Water Ltd, contractors	40	-	-
Dâmbovița River	Bucharest	Romania	U	2M	Wastewater treatment in Bucharest	The main objective of the project was to increase the capacity of the urban wastewater treatment plant (to about 2.2 million inhabitants) and to improve the technology using two lines built in two phases. The first stage of the project began in 2007 and was completed in 2011. This included rehabilitation of mechanical treatment and extension of biological treatment to include nitrogen removal and construction of a drainage system with rainwater storage capacity. The second phase of the project is scheduled for 2016-2021 (according to the 2nd River Basin Management Plan (RBMP)) and will build Line II of the wastewater treatment plant to increase treatment capacity. The project also aims to increase the fermentation capacity for sludge treatment by adding thickening and drying equipment. In addition, an incinerator will be built to ensure the entire sludge management process.	The legal obligation to meet the UWWTD (Urban Wastewater Treatment Directive)	2007	2021	A biological and chemical phosphorus treatment installation was built, and construction was completed on sludge anaerobic digesters as well as the necessary capacity for thickening and dewatering the sludge, including biogas reservoirs. In addition, the project included the construction of a drainage system and storm water storage capacities/ Rehabilitating and extending the wastewater treatment plant has reduced the amount of the pollutants – mainly organic, suspended solids and nutrients (total nitrogen and total phosphorus). The second stage of the project is planned for 2016-2021 and will build Line II of the wastewater treatment plant to increase the treatment capacity. The project aims also to increase the capacity of fermentation for sludge treatment, adding thickening and drying equipment. In addition, an incinerator will be built to ensure the entire process of sludge management. (http://www.icpdr.org/main/publications/spot-no-more-wastewater-treatment-plantbucharest)	Government of Romania, Bucharest City Hall, European Commission	-	127,6 million + 412,3 million	European Commission and the Romanian government
Luppe River	Leipzig	Germany	U	610 329	Revitalization project in Leipzig's urban floodplain forest – Living Luppe	The objective of the project is to revitalize more than 16 km of an ancient river course in the Leipzig floodplain ecosystems (Scholz et al., 2015, 2016). The goal is for significant flooding to reach large areas of the floodplain through a new fluvial course. It is planned to flood at least 30% of the floodplain area through the new river. The water table should be stabilized and raised by about 1 meter in most of	Highly impacted river morphology and need for better flood retention areas	2012	-	the revitalization of more than 16 km of a former river course in Leipzig's floodplain ecosystems (Scholz et al., 2015; 2016)/	by the cities of Leipzig and Schkeuditz, NGO NABU, Centre for Environmental Research - UFZ, University of Leipzig	16	-	Federal Agency for Nature Conservation and the State of Saxony

Water Body Name	City	Country	R/U/P *	Inhabitants	Project's Name	Short description of the Project	Project's Motivation	Beginning Date	Finishing Date	Implemented Measures	Stakeholders	Extension (km)	Cost (U\$)	Paid by:
						the project area. In addition, in an old dredging area (Papitzer Lachen) within the floodplain Weiße Elster are planned measures to increase the typical water supply of the floodplain. The revitalization of Luppe stretches should help combat water scarcity in the floodplain and again increase the diversity of floodplain species. The project (http://www.lebendige-luppe.de/) also emphasizes the communication of the importance of the floodplain to people and nature. The project is considered part of a mosaic of different measures required to achieve a more sustained revitalization of the floodplain in the future and is planned as a measure without regret (Scholz et al., 2016).								
Podutik Reservoir	Ljubljana	Slovenia	P	283 820	Multi-function flood reservoir Podutik in Ljubljana	Part of the flood reservoir Podutik has been redesigned into a multi-functional flood reservoir with enhanced ecosystem services via ecosystem technologies (ET) for stormwater management. The ecosystem technology was constructed within the flood reservoir consisting of a constructed wetland and a new river bed with meanders to provide several functions regarding environmental protection, namely a) Flood prevention, b) Water retention for irrigation purposes of nearby green areas; c) Water pollution mitigation from urban gardens and sewage overflows; d) Increased self-cleaning capacity of the ecosystem; e) Increased biodiversity; f) Establishment of recreation and education path.	Water quality problems and the 2010 flood event	2006	-	Part of the flood reservoir Podutik has been redesigned into a multi-functional flood reservoir with enhanced ecosystem services via ecosystem technologies (ET) for stormwater management/ The ecosystem technology was constructed within the flood reservoir consisting of a constructed wetland and a new river bed with meanders to provide several functions regarding environmental protection	Faculty of Civil and Geodetic Engineering and the Faculty of Health Sciences at the University of Ljubljana	-	-	-
Mayesbrook River	London	United Kingdom	U	8 M	Restoring Mayesbrook	The river itself has been restored with 500m of new sinuous water channels to help slow high flows and create habitat diversity, and 450m of regraded banks to increase the	Identified need for revitalisation of the park and water quality improvements	2008	-	Restoration with 500m of new sinuous water channels to help slow high flows and create habitat diversity, and 450m of regraded banks to increase the capacity of the river and improve the riverside habitat/ At the heart of the redesigned park is a new 1.5 ha floodplain that will	London Wildlife Trust and the Greater London Authority (Priority Parks fund via 'Help a London Park' competition), Design for London, River Restoration Centre, Thames Water, Olympics Development Association	-	-	RSA Ltd and the SITA Trust, London Tree and Woodland Grant

Water Body Name	City	Country	R/U/P *	Inhabitants	Project's Name	Short description of the Project	Project's Motivation	Beginning Date	Finishing Date	Implemented Measures	Stakeholders	Extension (km)	Cost (U\$)	Paid by:
						capacity of the river and improve the riverside habitat. The project was a springboard for water quality improvement work. The reed beds were installed to address one unresolved misconnection within the park and 225 properties rectified their misconnections as a result of the Thames Water's liaison. Huge amounts of fat, oil and grease had been entering the surface water system over a long period of time from this misconnection.				safely store floodwater and slowly release it/ The floodplain has been designed as a complex patchwork of gravel riffles, runs, seasonal ponds, reed beds, acid grassland and scrub vegetation, and now provides home for a range of wildlife rarely seen in one of the most deprived boroughs in London/ water quality improvement work/ The reed beds were installed to address one unresolved misconnection within the park and 225 properties rectified their misconnections as a result of the Thames Water's liaison.				Scheme, London Underground
Dyle River	Leuven	Belgium	U / P	100 166	Flood protection / restoration of the river Dyle, city of Leuven	This project began with traditional hydraulic solutions, in particular a large flood reservoir in Neerijse valley upstream of Leuven. During the design period of these traditional hydraulic solutions, growing environmental awareness led Leuven to explore more nature-based solutions that take the ecological health and landscape value of the river valley into consideration (La Rivière 2014). Protection against floods by upstream attenuation, flood prevention and damage avoidance (incl. integration of flood resistance and space for water in regeneration areas in the centre of Leuven), awareness and preparedness (communication campaigns, historic flood marks in the city), assistance before, during and after a flood.	Persistent flooding events	2006	-	the design of traditional hydraulic solutions, in particular a large flood reservoir in Neerijse valley upstream of Leuven/ growing environmental awareness led Leuven to explore more nature-based solutions that take the ecological health and landscape value of the river valley into consideration (La Rivière 2014)/ Based on new modelling software and taking into account the ecological requirements, the protection measures worked out, include a controlled flood reservoir in Egenhoven and natural, uncontrolled flood zones in the Neerijse valley (La Rivière 2014.)/ Infrastructure works are kept to a minimum and are intended to 'guide' for the river rather than to contain it (La Rivière 2014)/ Additional measures are currently being considered under the Flood Risk Management Plan (FRMP) to implement the EU Floods directive, on the basis of work and stakeholder consultation taking place in the EU project Flood Resilient City (FRC)/ Protection against floods by upstream attenuation, flood prevention and damage avoidance (incl. integration of flood resistance and space for water in regeneration areas in the centre of Leuven), awareness and preparedness (communication campaigns, historic flood marks in the city), assistance before, during and after a flood.	Operational Water Department of the Flanders Environment Agency (VMM), City of Leuven Agency for Nature and Forest (ANB), Catholic University of Leuven, project developers (regeneration projects).	86	-	VMM
						In the EU project Flood Resilient City (FRC), the Flanders Environment Agency implemented a number of measures to enhance the capacity of the channel network within the city. The existing quay-walls were improved to maintain the discharge capacity in the city centre. This was done in close contact with the riparian owners. In that way they became more aware of the river flowing next to or close to their houses. At			-	Although the capacity enhancements will be relatively small, when these are coupled with flood resistant and resilient constructions, they will help to reduce the amount of storage required upstream. In the EU project Flood Resilient City (FRC), the Flanders Environment Agency implemented a number of measures to enhance the capacity of the channel network within the city. The existing quay-walls were improved to maintain the discharge capacity in the city centre. During high water the steps can flood. This increases the capacity for the river in the city centre. Additionally the terrace helps to make more people in Leuven aware that the Dijle is a living river, and	Operational Water Department of the Flanders Environment Agency (VMM), WFD			

Water Body Name	City	Country	R/U/P *	Inhabitants	Project's Name	Short description of the Project	Project's Motivation	Beginning Date	Finishing Date	Implemented Measures	Stakeholders	Extension (km)	Cost (U\$)	Paid by:
						one location it was possible to build a terrace alongside the river and a small park for people to enjoy. During high water the steps can flood. This increases the capacity for the river in the city centre. Additionally the terrace helps to make more people in Leuven aware that the Dijle is a living river, and that there is an ongoing threat of flooding (Source: http://www.floodresiliency.eu)				that there is an ongoing threat of flooding (Source: http://www.floodresiliency.eu)				
Sokolowka River	Lodz	Poland	U	768 755	Restoration of the Sokolowka River	The restoration of the Sokolowka River is part of an urban development programme centred on water and river restoration in Lodz. Five retention reservoirs were built on the Sokolowka River. As the river has different land conditions (size of catchment area, topographical feature), each of the reservoirs has its own style. But all of them have two main functions -water retention and recreation. In 2001 the Łódź City Office developed a Small Retention Programme, which covers the whole city. There were more than 50 reservoirs within the administrative borders of Lodz, and the programme proposed the construction of an additional 30 reservoirs.	Most of Lodz rivers work as a part of a combined sewerage system of the city. During heavy rains rivers intercept waters from overflows and rain water. Waters from combined sewage overflows and stormwater outflows pollute rivers several times per year. Shortage of stormwater retention reservoirs is one of the reasons for pollution of the Ner river, which receives combined sewage from the entire city. The repeating problems related to pollution, overflows and ecological degradation made the city look for possibilities of stormwater retention, and for improving the ecological quality of the rivers, thus creating friendlier and healthier public space.	2000	2012	design of a sequential stormwater sedimentation/ biofiltration system which prevents the influx of pollutants into the river during high flows (Zalewski, et al., 2012)/ the design and construction of three stormwater reservoirs with increased river retention/ pollution absorption capacity, thanks to adjusted biotic structures and hydrodynamic adjustment/ the elaboration of development plans for further rehabilitation of the river valley.	European Regional Centre for Ecohydrology u/a UNESCO; City Office Lodz	-	-	EU funding
Quaggy River	London	United Kingdom	U	8 M	Quaggy River in Sutcliffe Park	The restoration of the River Quaggy is part of the London Rivers Action Plan (2009). To provide further flood water storage, the park itself was lowered and re-shaped to create a floodplain capable of storing a maximum of 85,000 cubic metres of flood water. A network of boardwalks, pathways and viewing points were designed to encourage access to the river and ponds, all of which were an integral part of the scheme (LRAP 2009).	There have been considerable flooding problems along River Quaggy in previous years, most notably in 1968 when Lewisham town centre was flooded to a depth in excess of 1 metre, and a smaller flood in 1992. Historically, these have been caused by urban development in the river valley and the natural flood plain.	2003	2007	A new 'low-flow' meandering channel was cut through the park, following its original alignment/ The previous culvert was retained, enabling it to take excess water in times of extreme flood events/ Flow is now regulated between the two watercourses by a sluice/ To provide further flood water storage, the park itself was lowered and re-shaped to create a floodplain capable of storing a maximum of 85,000 cubic metres of flood water/ A network of boardwalks, pathways/ viewing points were designed to encourage access to the river and ponds, all of which were an integral part of the scheme. (LRAP 2009).	Environment Agency; QWAG (Quaggy Waterways Action Group); Breheny Engineering; London Borough Greenwich; London Borough Lewisham	5,6	-	-
Yzeron River	Lyon	France	U / P	495 000	Flood protection / restoration in the River	The restoration project involves the removal of the concrete culverts and revegetation of the banks	After two important floods in 1989 and 1993, the signing of the Yzeron river contract in 2002 was the first concerted planning and	2012/2014	-	the river's corridor will be expanded, additional width for the channel will come from a combination of narrowing an adjacent road and selective removal of	SAGYRC, Greater Lyon, the Compagnie Nationale du Rhone (CNR), the Federation of Fisheries of the Rhone, contractors	-	-	The water agency Rhone Mediterranee

Water Body Name	City	Country	R/U/P *	Inhabitants	Project's Name	Short description of the Project	Project's Motivation	Beginning Date	Finishing Date	Implemented Measures	Stakeholders	Extension (km)	Cost (US\$)	Paid by:
					Yzeron, city of Lyon	in order to foster a wildlife corridor with flora and fauna. The simultaneous widening of the river and construction of two dams aids in flood control during the wet seasons. Taking residents' feedback into account, the project also places high value on the landscape quality of the river, providing a social service to locals seeking to relax and enjoy (Flaminio et al.n.d.). Thus while the original project mainly addressed increasingly frequent flooding, it came to include interests in the river's ecological, social and recreational services. In parallel, works are being conducted by Lyon Métropole (formerly named Greater Lyon) on the combined sewer system, to reduce overflows and emissions during rainy weather	management action programme implemented in the watershed. SAGYRC (Syndicat d'Aménagement et de Gestion de l'Yzeron, du Ratier et du Charbonnières), an intercommunal Union, bringing together 20 member municipalities, has been responsible for the management and implementation of the river contract. The reference flood (the largest recorded flood) is now that of 2003 (30 year flood)			structures/ The restoration project involves the removal of the concrete culverts and revegetation of the banks in order to foster a wildlife corridor with flora and fauna/ The simultaneous widening of the river and construction of two dams aids in flood control during the wet seasons/ inclusion in the river's ecological, social and recreational services/ In parallel, works are being conducted by Lyon Métropole (formerly named Greater Lyon) on the combined sewer system, to reduce overflows and emissions during rainy weather.				an Corsica, Ministry, Lyon Metropole
Guadiana River	Mérida	Spain	U / P	60 589	Restoration of the Guadiana River in Mérida	In the urban areas the project aimed to properly integrate the riverbanks with the city, paying special attention to the aesthetic and archaeological aspects and taking advantage of them to provide the citizens with new green zones (parks) which in turn are compatible with occasional flooding and prevent the improper use of the areas adjacent to the river.	Protection against environmental degradation, flood prevention and urban landscape impacts related to the archaeological and monumental heritage.	1999	2003	Dig in the bottom of the river of two large canals (about 60 m wide each) to increase the hydraulic section/ Construction of a weir (small dam) at the downstream limit of the urban section to enable a stable water level in this section, and reduce the effects of the Montijo Dam/ Creation of a large urban park on the left bank, called "Parque de las Siete Sillas"/ Action on the big island existing on the right bank, raising its level, reforesting it, improving the access to it and establishing sports facilities there/ Creation of linear parks on the right bank in the areas of "Alcazaba" (close to a castle from the Islamic period) and "Paseo de Roma"/ Creation of another large urban park on the right bank, the Park "Pancaliente" around the old mill that gives it its name, ("Molino de Pancaliente") and whose restoration has also been undertaken as part of the initiative/ Installation of lightning systems on the Roman bridge, one artistic and one for the pedestrians	Confederación Hidrográfica del Guadiana and Ministry of the Environment, Junta de Extremadura (Regional Government of Extremadura), Ayuntamiento de Mérida (Mérida Council), Consorcio de Mérida (the organization which manages the monumental and archeological heritage in Mérida) and some NGO's, like vicinal, sport and ecologist associations.	744	33,4 million	Co-financed by European Cohesion Funds
Isar River	Munich	Germany	U	1 568 331	Urban river restoration on the River Isar, city of Munich	the Isar-Plan was launched in 1995 as an initiative that integrated the goals of flood-protection, ecological restoration, and recreational use (Arzet and Joven, n.d.; Reiss-Schmidt, 2014). The measures implemented included inter alia the renaturation of river banks, the enhancement of accessibility and improving the flood defences by bringing the	Heavy rain events leading to major floods and substantial financial damage in the South of Germany	1995	2011	inter alia the renaturation of river banks, the enhancement of accessibility and improving the flood defences by bringing the dykes to the latest state of the technology (reinforcing the core of the existing dyke, as well as improving surface sealing).	State of Bavaria, City of Munich, NGOs and population	270	-	55%: provided by the state of Bavaria 45%: provided by the City of Munich

Water Body Name	City	Country	R/U/P *	Inhabitants	Project's Name	Short description of the Project	Project's Motivation	Beginning Date	Finishing Date	Implemented Measures	Stakeholders	Extension (km)	Cost (U\$)	Paid by:
						dykes to the latest state of the technology (reinforcing the core of the existing dyke, as well as improving surface sealing).								
Waal River	Nijmegen	The Netherlands	U	180 871	Room for the River Waal, city of Nijmegen	The new project area connects two bird and habitat area's Gelderse Poort and Uiterwaarden (Floodplains) Waal. No water quality improvements are foreseen. Hydraulic connection between the river and part of its floodplain is being restored by moving the dyke backwards by 350m, and developing a new channel within the floodplain that will always contain water and will provide additional flood capacity. On the island there will be a new development area for nature. No ecological valuable area was lost or altered during the intervention. (NWRM, n.d.).	Risk of flooding, particularly following flooding events in 1993 and 1995	2013	2016	The flood protection measures are incorporated with urban development measures that will provide aesthetic and recreational benefits, together with an enhancement of the spatial quality in the area (NWRM, n.d.).	Rijkswaterstaat, Ministerie van Infrastructuur en Milieu, Staatsbosbeheer	-	-	-
Emscher River	Ruhrgebiet	Germany	U / P	5 M	Emscher River re-conversion	The restoration and renaturation measures are part of a regional strategy called the "Emscher Future" Master Plan. This plan has 8 general principles: standards for flood prevention, ecological development of the aquatic system, connection with the environment, clear and corporate design of constructions and the development of open spaces, quality of life enhancement, profit from economic potential, incorporating history of the region	Decline of the mining industry and the conviction of the responsible authorities (Emschergenossenschaft/Lippeverband) to re-convert the river and its tributaries into natural waterways.	1989	2020	264 km of sewers constructed so far and 400 km more to be completed by 2017./ 91 combined sewer overflow (CSO) structures have been built in the area until now and 290 more are planned until 2017/ In 2020 the Emscher reconversion project aims at the ecological revitalization of 350 km of water courses in an area of 865 km² (IWW Water Centre, 2014)./ The creation of a sewer network including Combined Sewer Overflows to make the Emscher a wastewater-free river/ The conversion of the Emscher into a collector for pretreated runoff and rainwater/ The enhancement of the ecological connectivity of the river/ The provision of new spaces for recreation and enhanced urban dwelling, increasing the quality of life in the area	Led by the regional water board "Emschergenossenschaft/Lippeverband", the Emscher Future Master Plan has been developed in continuous dialogue with neighbouring cities and districts, citizens, with industry and business, the relevant government authorities and many other organisations and institutions (www.eglv.de).	-	-	-

Information marked "-" was not found until the closing date of this work.

*Urban, Rural or Peri-urban Area

Elaborated by the author, 2018

Statutory Declaration

I declare that I have developed and written the enclosed Master Thesis completely by myself and have not used sources or means without declaration in the text. Any thoughts from others or literal quotations are clearly marked. The Master Thesis was not used in the same or in a similar version to achieve an academic grading or is being published elsewhere.

Tours, 18th June 2018

Marina Fernandes Leite