Contributions of the French Strategic Environmental Assessment to Brazilian planning in water source areas: the Billings Reservoir sub-basin case

Contribuições da Avaliação Ambiental Estratégica francesa para o planejamento em áreas de mananciais no Brasil: o caso da Sub-bacia do Reservatório Billings

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ABSTRACT

Strategic Environmental Assessment (SEA) is a tool that aims to integrate environmental issues into decision-making processes, usually to support the development of sectoral or territorial plans and programs. SEA is mandatory in the European Union and is applied to water management in France. Water management in Brazil is inspired by the French model, but does not have SEA; in the state of São Paulo watersheds of interest for public supply have specific norms and can count on a Development and Environmental Protection Plan (PDPA). In this research we explore three potential contributions of SEA as adopted in French water management for the case of the PDPA of the Billings Reservoir sub-basin. We conducted an evaluative case study for this PDPA, a literature review on French practices, and comparative analysis. We conclude by indicating potential contributions of SEA for the definition of objectives, scoping, and study of alternatives of the PDPA-Billings.

Keywords: Environmental Planning. Water Resources Management. Public Policy. Protected Springs. Area of Protection and Recovery of Watersheds.

RESUMO

A Avaliação Ambiental Estratégica (AAE) é um instrumento que visa integrar questões ambientais em processos decisórios, geralmente visando apoiar a elaboração de planos e programas setoriais ou territoriais. A AAE é obrigatória na União Europeia, sendo aplicada à gestão da água na França. A gestão da água no Brasil é inspirada no modelo francês, mas não conta com AAE; no estado de São Paulo, bacias hidrográficas de interesse para abastecimento público têm legislação específica e suporte de um instrumento chamado Plano de Desenvolvimento e Proteção Ambiental (PDPA). Nesta pesquisa exploramos três potenciais contribuições da AAE como adotada na gestão da água francesa para o caso do PDPA da Sub-bacia do Reservatório Billings. Foi realizado estudo de caso avaliativo desse PDPA, revisão bibliográfica sobre as práticas francesas e análise comparativa. Concluímos indicando potenciais contribuições da AAE para a definição de objetivos, definição do escopo e estudo de alternativas do PDPA-Billings.

Palavras-chave: Planejamento Ambiental. Gestão de Recursos Hídricos. Política Pública. Avaliação de Impacto. Área de Proteção e Recuperação de Mananciais.

1 INTRODUCTION

Strategic Environmental Assessment is an environmental policy instrument widely adopted to integrate environmental issues into decision-making processes of various contexts in sectoral and territorial planning (DUARTE, 2017; EUROPEAN UNION, 2001; THÉRIVEL, 2010). However, in Brazil, the use of this instrument is not mandatory and has been applied heterogeneously and rarely in the context of water management (MALVESTIO; MONTAÑO, 2019; TSHIBANGU; MONTAÑO, 2019).

In Brazil, water management faces considerable challenges from protecting water sources in urban areas. One of the notorious cases is the Billings Reservoir, located in the Alto Tietê River Basin; it is the largest water source of the Metropolitan Region of São Paulo (RMSP, *Região Metropolitana de São Paulo*) with a drainage area of about 580 km² (SMA/CPLA, 2010).

According to estimates, the Billings Reservoir can supply about 4.5 million people. However, it supplies only about 1.5 million people due to severe water quality degradation (FABHAT, 2019; SÃO PAULO, 2010). This occurs mainly due to the intake of the high load of *in natura* domestic effluents from areas without basic sanitation infrastructure and also through the pumping of the waters of the Pinheiros River, degraded for the same reason for decades (CARMO; TAGNIN, 2001; DUARTE; MALHEIROS, 2012; MARICATO, 2003; RISSO *et al*., 2018).

An attempt to protect this area emerged in the 1970s with a set of state statutes for protecting water sources (mainly State Laws No. 898/1975 and No. 1172/1976), which sought to restrict occupation in the watersheds of interest for the RMSP. Nonetheless, the restriction posed by the laws have kept formal projects away, and given the massive housing deficit in the RMSP, the region attracted informal housing without urban infrastructure. In this scenario, in 1997, State Law No. 9866 was passed, which intended to protect and recover the environmental quality of watersheds, bringing new instruments to this end (DUARTE *et al.*, 2010; SÃO PAULO, 1997).

The statute established that each watershed considered a water source of regional interest should be a Protection and Restoration Watershed Area (APRM, *Área de Proteção e Recuperação dos Mananciais*), to contemplate the singularities of these different regions. APRMs must have specific regulations, planning, management instruments, and a Development and Environmental Protection Plan (PDPA, *Plano de Desenvolvimento e Proteção Ambiental*) to define regional and local development guidelines for the promotion of environmental rehabilitation or restoration. To this end, the PDPA must combine water resource management and territorial management instruments, recognizing that land use is

a fundamental theme for protecting water sources (SÃO PAULO, 1997). In this context, the Billings reservoir watershed has been defined as an APRM and has its PDPA.

Despite the water crises scenarios in the RMSP over the last decade, there are only a few scientific research results related to the effectiveness of the water source areas statutes and its instruments (ALVIM; KATO; ROSIN, 2015; FERRARA, 2018; IKEMATSU, 2014). Still, recent water quality data indicate a scenario of degradation and worrying trends (FABHAT, 2019), suggesting the need to evaluate and improve current practices and instruments.

In the reference practices in water management, the French system stands out as a benchmark for numerous countries with different government regimes and political-administrative features (ACADÉMIE DE L'EAU, 2013). Besides that, in France, SEA is adopted as an instrument that promotes the systematic integration of environmental issues into water planning. Other authors identified potential contributions to the Brazilian context (GULLÓN, 2005; SAINTS; PIZELLA; SOUZA, 2020).

Thus, this research attempts to answer the following question: as adopted in the French water management system, what contributions could SEA bring to PDPA-Billings? In this article, we explore three potential contributions in this context, selected after identified in a preliminary analysis of possible contributions, which correspond to the stages of the definition of objectives, scoping, and study of alternatives.

Next, we present the description of water planning in Brazil and France in the theoretical framework, briefly comparing the instruments adopted in both countries. Next, there is a description of the evaluative case study on PDPA-Billings and the literature review of the French context in the methods. The results indicate three practices in the French system that could potentially improve the context under analysis. Finally, we present the discussions and conclusions that problematize and synthesize the contributions of this research.

2 THEORETICAL FRAMEWORK: WATER PLANNING INSTRUMENTS IN BRAZIL AND FRANCE

Brazil, inspired by the French model and following the global trend, in its National Water Resources Policy (PNRH, *Política Nacional de Recursos Hídricos*, Federal Act No. 9433/1997) grants the creation of two new institutions in the territorial cutout of river basins: the River Basin Committee (CBH, *Comitê de Bacia Hidrográfica*) and the Water Agency. However, the creation of the CBH as a new participatory instance for decision-making, encompassing the federative entities (Nation, states, and municipalities) and other social actors, poses enormous challenges as it demands more integration efforts and governmental articulation (MIRANDA, 2020).

The PNRH also provides a set of instruments that, supported by a database accessible to the public, establishes rules and incentives for the rational use of water resources, quality goals, programs, and measures to meet multiple uses. In this context, the water resource plans stand out among the planning instruments (MIRANDA, 2020; PORTO, M. F. A.; PORTO, R. L. L., 2008). While national and state water resources policies establish significant planning and management guidelines, water resource plans aim to support and guide the implementation of water resources policies, taking into account the environmental protection, planning, and management guidelines currently in force. Water resource plans can be designed for river basins, states, and the country. Therefore, the elaboration process should consider definitions from other projects, regional and sectoral, attempting to make different objectives and actions compatible.

Following the national and state plans, the River Basin Management Plans (PBH, *Plano de Bacia Hidrográfica*) are prepared with the technical support from the Water Agencies and approved by the

CBHs. The PBHs present an executive approach, articulating short, medium, and long-term demands, integrating environmental, economic, and social issues (MILARÉ, 2014). Through a process guided by the agendas and discussions held at the CBHs, the PBHs must operationalize the objectives and goals of sustainability and water security defined in the territorial plans for larger scales, considering the interests of water users, the government, and the organized civil society (PINHEIRO *et al*., 2019).

In the state of São Paulo, associated with water management, there is also the definition of APRMs and the elaboration of PDPAs. Since they are in sub-basin scales, they can bring specific details to a given region, an essential link between the PBHs and local planning initiatives (CPLA/SMA, 2010). Unfortunately, none of the mentioned planning instruments has SEA in the Brazilian case.

In France, in 1964, with the Water Act No. 64-1245, the watershed was adopted as a planning unit, defining six large basins or groups of watersheds in the French territory. Two fundamental institutions also operate in each country's major basins: the River Basins Committees and the Water Agencies (MACHADO, 2003). As there is a tripartite representation among water resource users, collectivities and public administration, the CBHs constitute consultative and deliberative roles for water use conflicts in these river basins. On the other hand, the water agencies are the ones that make the management possible as they are responsible for the administration of resources collected from the charging of the uses of water resources (MARTINS, 2008).

In 1992, a new Water Act (Act No. 92-3) recognized water as a national heritage, the preservation and restoration of aquatic environments as a character of general interest and adhering to the principle of balanced management between the interests of users and the protection of aquatic ecosystems (LANNA; PEREIRA; HUBERT, 2002). Among the valuable contributions of the 1992 Water Act, the establishment of two new planning instruments stands out: the SDAGEs (*Schéma Directeur d'Aménagement et de Gestion des Eaux*) and the Sages (*Schéma d'Aménagement et de Gestion des Eaux*). The SDAGEs are strategic plans that set, for 6 years, quality targets for water resources in the Hydrographic Regions – the territory of large river basins, river basin groups, overseas territories – considering the guidelines of the National Policy and the European Union's Directives on water resources. Focused on themes related to the articulation and sectoral cooperation, the SDAGEs define guidelines for the (balanced) management of water resources. They are mandatory, being prepared by the Water Agencies, under the guidance of the Basin Committees (BOHN *et al*., 2008; LANNA; PEREIRA; HUBERT, 2002).

The Sages are long-term plans (10 to 15 years) that establish the objectives and rules for using, exploiting, and protecting water resources and aquatic ecosystems. They consider the guidelines and priority areas of action defined by the SDAGEs and applicable to watersheds, watershed groups or aquifer system, whose elaboration require the participation and deliberation of local powers (PIÉGAY; DUPONT; FABY, 2002; BRAGA; BRAGA; STINGER, 2015). They are optional, mandatory only in sub-basins identified as priorities in the SDAGEs (SANTOS; PIZELLA; SOUZA, 2020). Not coincidentally, the preparation, review, and monitoring of the SAGEs is the responsibility of the Local Water Commissions (LWCs), decentralized instances composed of representatives from the territorial collectivities, water users, and the State (BERRETA; LAURENT; BASSO, 2012).

In 1981 the French Ministry of the Environment created the figure of the *contrats de milieu*, translated here as an environmental contract, a 5-year action plan, which establishes a contractual financial commitment between local and regional actors, focusing on the implementation of the actions and projects foreseen in the SAGEs (PIÉGAY; DUPONT; FABY, 2002). Thus, while Sage plays the role of planning and guiding actions at the sub-basin level, the environmental contract is a commitment between the segments involved with water management, establishing objectives, goals, deadlines, and consensual responsibilities to fulfil the Sage.

It is important to note that in the 2000s, two new European standards influenced water management in France. First, *the Water Framework* Directive (WFD) (2000/60/EC) defined that developing water

resources plans should consider environmental characteristics of the area of coverage, the revision of environmental impacts on water quality and the influences of current legislation on achieving their objectives. It signalled the importance of integrating the environmental variable in water resources planning (GULLÓN, 2005).

Subsequently, the SEA Directive (2001/42/EC) established the obligation to carry out SEA during plans and programs likely to affect the environment significantly. According to this Directive, the SEA ensures the environmental effects of implementing the plans and programs during their preparation, before approval (EU, 2001). Therefore, the SEA is an instrument that supports the development of SDAGEs and Sages since the publication of the legal norm, transposing to the French law the requirements of the SEA Directive (*Ordonnance* No. 2004-489 of 3 June 2004).

Thus, according to the latest version of the National Guide for the Preparation of Sages (FRANCE, 2015), SEA must:

I. Provide elements for the identification of the main trends of environmental aspects in the area and scope of the Sage to support the definition of a strategy compatible with the sustainable use of water resources;

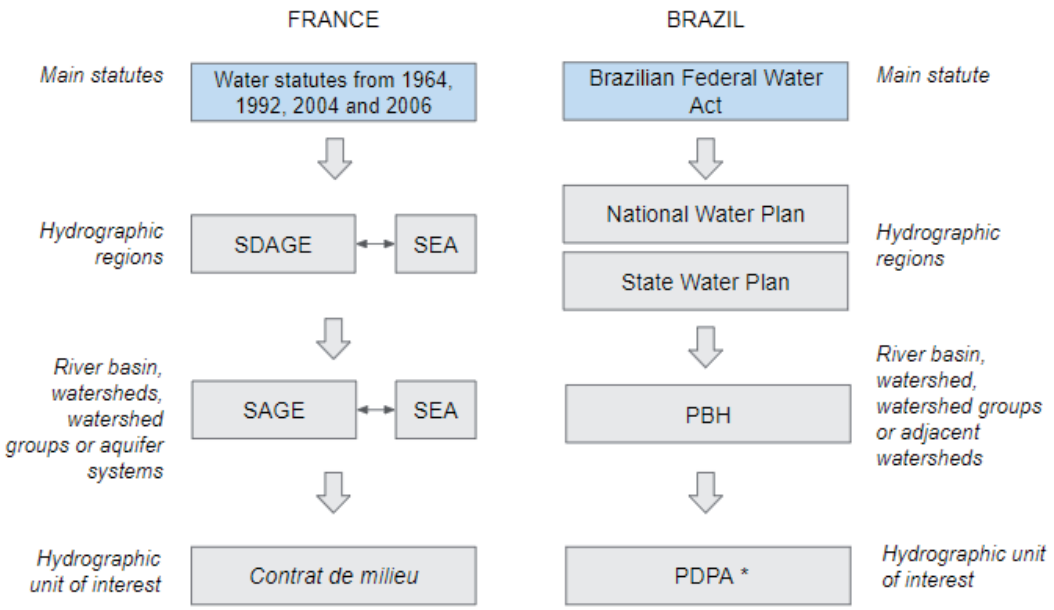
II. Assist in defining the content of the Sage, anticipating environmental impacts, preventing, reducing, or offsetting adverse effects on the environment, including cumulative impacts;

III. Ensure consistency with development strategies in its area of coverage and justify the choices made in terms of environmental protection objectives and;

IV. Strengthen participation through a process of consultation with the public and competent authorities.

In 2006, France's water resource management system, established from Act No. 64-1245 of 1964 and implemented through Act No. 92-3 in 1992, was updated again by the Water and Aquatic Environments Act (LEMA*, Loi sur l'Eau et les Milieux Aquatiques*, Loi No. 2006-1772, 2006). This law reformed the various existing codes, seeking to meet the quality goals established in the WFD, and reinforced the legal scope of the Sages, defining that the rules specified in the Sage have broad validity in its area of coverage, overlapping any contrary decision. (BOHN *et al.*, 2008). Thus, unlike Brazil, France has four primary laws related to water management, one of which transposes the WFD into the French context.

Focusing on Brazil and France's main water planning instruments presented above, Figure 1 shows a simplified relationship between the instruments, identifying their application scale.



* Instrument provided for the context of water management in São Paulo.

Figure 1 | Comparison between the water planning instruments and their territorial scale in France and Brazil, including the PDPA adopted in the state of São Paulo.

Source: Prepared by the authors.

In France, SEA is designed for SDAGEs and Sages; and the *Contracts de Milieu* benefit from a planning system in which their predecessors have previously assessed environmental issues. Nevertheless, other sectoral and territorial planning instruments in France also have SEA as a support planning tool, such as the land use plans. Hence, the environmental contracts always have previous planning and decisions in which there had already been put efforts to include environmental issues. Furthermore, the parallel between Environmental Contracts and the PDPA does not mean the alignment of content and objective, but only that these are the instruments applied on a similar scale.

3 METHODOLOGY

Three stages constitute this research. The first one presents an evaluation of the PDPA-Billings, developed from the proposal of a case study by Yin (2015), with data triangulation from a documental and bibliographic review and five semi-structured interviews with agents involved in water source management or specialists in water resources. The information obtained in the case study follows the sustainability assessment criteria proposed by Gibson (2006), organized as questions and answers elaborated in an iterative process, with new questions and answers added to the construction of the case study, as in Duarte *et al.* (2013). The criteria used for the analysis were: Integrity of the socio-ecological system, livelihood sufficiency and opportunity, intra- and intergenerational equity, resource maintenance and efficiency, socio-ecological civility and democratic governance, precaution and adaptation, and immediate and long-term integration (GIBSON, 2006).

The documentary research aims to build a description of PDPA-Billings as to its content, history, context and plans related to it. The second version of the PDPA-Billings published in 2017 (SSRH, 2017) was adopted as a reference. A brief presentation of the plan is presented in section 4.1.

The bibliographic research investigated the history and critical analyses related to the criteria above for the context of the Billings Reservoir sub-basin, carried out from a search in the Capes Periodical Portal *and* Google Scholar.

The interviews were conducted with the Research Ethics Committee of the Universidade Federal de São Paulo's approval (Brazilian Certificate of Presentation for Ethical Consideration, CAAE, 31770720.0.0000.5505). The questions addressed the plan's content, weaknesses, strengths, and perspectives on what could be improved. A member of the Billings-Tamanduateí Subcommittee (interviewee E1), a former Environment Secretary of the Municipality of São Bernardo do Campo (E2), a representative of the consultancy responsible for the elaboration of PDPA-Billings and other PDPAs in the Alto Tietê river basin (E3) and two water quality specialists (E4 and E5) constitute the interviews.

In the second stage of this research, a bibliographic review was conducted on the water resources planning and management system in France, focusing on the role of the SEA in this context. The National *Guide for the elaboration and environmental evaluation of Sages* (FRANCE, 2015), scientific articles, and, occasionally, consultations were made in official websites of interest, namely the page of the community of actors involved in the integrated management *of* water resources *Gest'eau* (www.gesteau.fr) and the platform of the public information dissemination service of France *Legifrance* (www.legifrance.gouv.fr). The literature review allowed the identification of analytical approaches, methods, and tools used in planning water resources in France. Subsequently, considering the similarities between the French and São Paulo water management systems, planning practices the São Paulo water planning system could explore were identified.

In the third stage, having as a reference the basic steps of a planning process supported by the SEA (DUARTE, 2017; THÉRIVEL, 2010, 2001), the authors carried out a preliminary critical analysis, listing and discussing the potential contributions of the SEA in the French context to the context of the PDPA-Billings. As a result of this analysis, the authors have thoroughly selected three themes to examine. The results are presented in section 4.2.

4 RESULTS

4.1 CHARACTERIZATION OF PDPA-BILLINGS AND BILLINGS RESERVOIR WATERSHED

The Billings Reservoir sub-basin had its area defined as an APRM in 2009, through State Law No. 13579/2009, the Billings Specific Act. Among other elements, environmental quality targets were determined using the phosphorus load and vegetation cover indicators and a zone for the entire basin with land use and occupation guidelines to be compatible with municipal master plans. In the following year, 2010, the first version of the PDPA-Billings was released, approved by the Billings-Tamanduateí Subcommittee, responsible for its management. In 2017, a new version came up, although not approved by the subcommittee at the moment of this research.

Given the extent and diversity of characteristics, the Specific Act divided the watershed into five environmental *compartments* (Figure 2), each with different guidelines and goals established in that act.

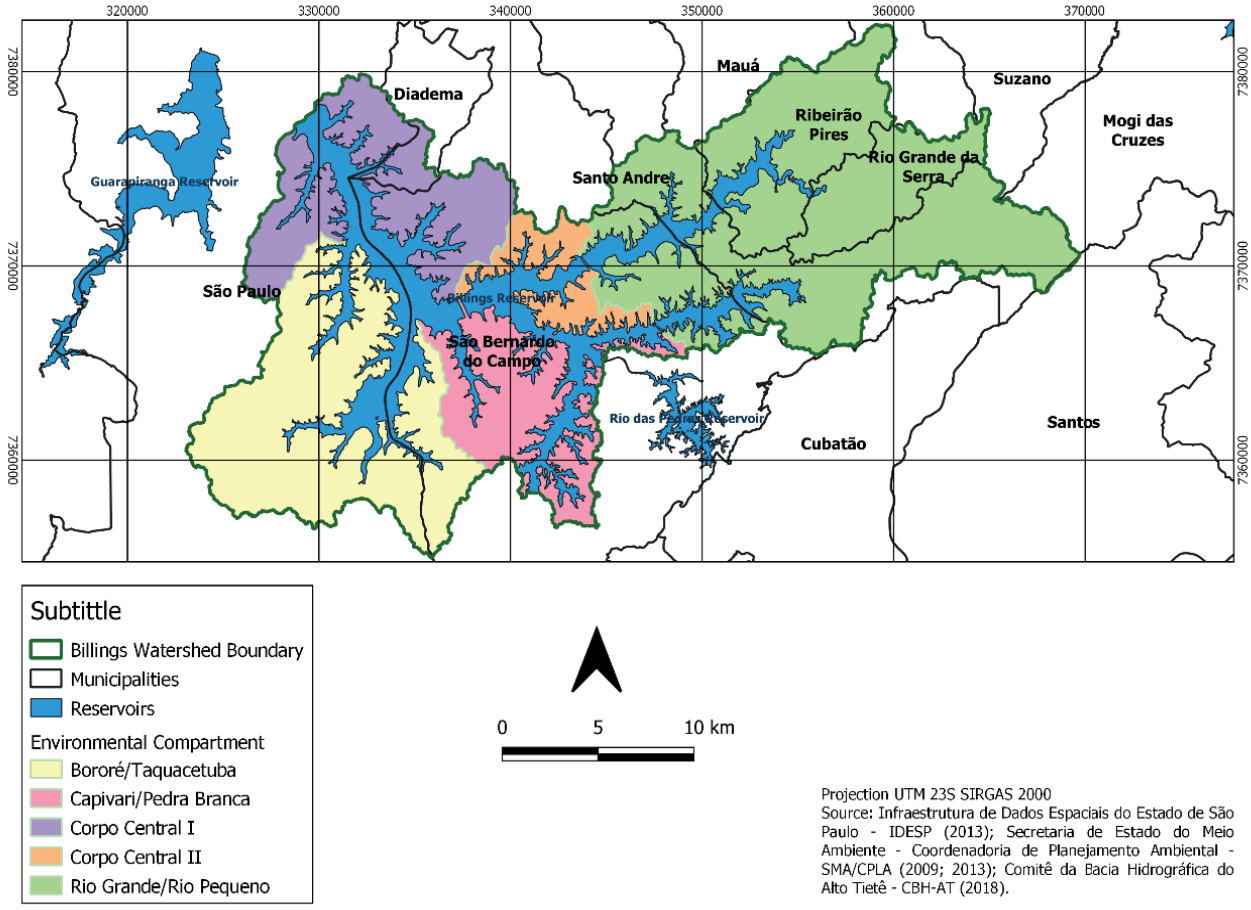


Figure 2 | The Billings Reservoir Watershed and its environmental compartments.

Source: Prepared by the authors.

With 213 pages, the content of the PDPA-Billings provides a brief introduction of the document, presenting the foundations for the management of the entire watershed. The second chapter shows a diagnosis of the basin, encompassing a brief history, the use and occupation of soil, territorial planning, socio-economics and demography, urban expansion vectors, sanitary infrastructure, protected areas, and water quality.

The third chapter introduces the *Modeling Scenarios,* which have adopted the Land Use and Water Quality Correlation Model (MQUAL, *Modelo de Correlação do Uso do Solo e Qualidade da Água*). A *General Evaluation* was also presented, exploring why the diagnosis is still far from the goals set in 2009, followed by proposals of adjustments in the zoning of the watershed. Finally, in the sixth chapter, the *General and Territorial Guidelines* are presented, guided by the Billings Specific Act, and directed to different sectors/themes. This study comprises six programs, seven sub-programs, 42 actions, structural and non-structural measures analysis, and the financing problem. Besides, the authors underline an *Investment and Resource Sources Program*, indicators for quality assessment and management and monitoring of the programs, and the *Final Considerations* of the plan.

4.2 EVALUATION OF PDPA-BILLINGS AND SEA CONTRIBUTIONS

From the evaluation regarding the PDPA's sustainability and the interviews conducted, it was possible to identify points that could be improved in the document, three of which better explored in this study and the practices of references of the French context that can contribute to overcoming them.

4.2.1 GOAL SETTING

The objective of the PDPA-Billings is not present in the document's text. However, it focuses on searching for strategies to improve water quality in the watershed, especially in the Billings reservoir. The quality targets defined by the compartment in the Billings Specific Act and explored in the PDPA are *phosphorus load* and *vegetation cover*. The PDPA-Billings deal with several fundamental themes for water quality. However, it covers a few actions from the water resource plans that precede it and other relevant sectoral and territorial public policies.

As highlighted in the interviews (E1 and E4), the absence of the climate change issue addressed within the criterion of socio-ecological system integrity needs attention. The lack of studies on the rainfall regime suggests a limited approach to the impacts of climate change in reaching the goals for achieving environmental quality standards. Climate scenarios would allow the definition of climate mitigation and adaptation measures and the delimitation of a broader set of management indicators of Billings APRM. Given the current climate emergency scenario, the analysis of climate scenarios emerges as an opportunity to deal with the uncertainties associated with water availability, adding value to the planning and management of complex environments, such as the water sources areas of regional interest (ANA, 2016). In addition, there is evidence of the inability of RMSP producer systems to meet the current and projected demand for water for public supply in the coming years in projections that consider climate change (BICUDO *et al*., 2015).

The WFD anticipates a reference framework with strategic objectives in the French context. Moreover, there is a deliberate transfer of information and environmental decisions from the SDAGEs to the Sages, both liable to SEA and which guide the planning of water resources in the scale of the watersheds (SANTOS; PIZELLA; SOUZA, 2020). The process of formulating the Sages integrates the WFD sustainability objectives and the recommendations of the SDAGEs, articulating local development with regional goals, in a multi-scale planning approach, favouring the consideration of strategic themes, such as biodiversity and climate change (SAINTS; PIZELLA; SOUZA, 2020; SILVA; FERREIRA; POMPEO, 2013).

Therefore, both the identification of the environmental baseline in SEA and the environmental diagnosis of the Sages are guided by sustainability objectives of the water system, considering, in addition to the parameters of water quality, other ecological related frameworks and environmental indicators. These indicators influence the entire SEA process and the Sage content, contributing to evaluating the proposed measures based on sustainability criteria (SANTOS; PIZELLA; SOUZA, 2020).

This chaining of the different strategic levels of planning, associated with the concept of cascading evaluation, establishes a more favourable structure for evaluation since the development strategies under analysis would have supported previous references in broader levels of evaluation (ARTS; TOMLINSON; VOOGD, 2011; FISCHER, 2007; LEE, 2006). In this context, the role of SEA is also to verify whether environmental objectives, established in various policies and standards, apply to the context under study.

Thus, the PDPA could count on multiple objectives related to the purposes of water resources plans that precede it – the National and State water plans and the Alto Tietê Basin Plan. The latter, ideally, could also count on the support of SEA. Therefore, this item is directly related to the planning stage that succeeds in defining the objective, which is the scope definition.

4.2.2 SCOPE DEFINITION

The first article of the water supply act (State Law No. 9866/1997) establishes that *guidelines and standards for the protection and restoration of the environmental quality of watersheds*, from the law, aimed at the use of assured public water *supply since multiple uses are compatible*. Besides public supply

and industrial use, the Billings reservoir serves different purposes, such as sports, subsistence fishing, recreation, swimming, ferry, tourist boats, and nautical sports (CARMO; TAGNIN, 2001; SSRH, 2017).

However, the PDPA text offers only specific considerations about the multiple uses in the basin. For water quality, the PDPA presents three different groups of information, which include (i) the information on the Water *Quality Monitoring area of the Water Protection and Recovery Area of the Watersheds of the Billings and Guarapiranga Reservoirs;* (ii) the phosphorus load data estimated through the application of the MQUAL during the preparation of the PDPA; and (iii) the indexes calculated by the Environmental Agency of the State of São Paulo (Cetesb, *Companhia Ambiental do Estado de São Paulo*), presented in *the Annual Report of Inland Waters of the State of São Paulo*, the Quality Index for Public Supply (IAP) and The Trophic State Index (IET). The IAP indicates the water quality at points where there is a collection or a transfer to other reservoirs, and the IET shows the enrichment by nutrients and the consequent effect on the population of algae and cyanobacteria (CETESB, 2020).

The absence of information or indicators related to water quality for recreational purposes of primary contacts, such as the Reservoir Balneability Index, or the protection of aquatic biota, such as the concentration of emerging pollutants, demonstrated the simple approach of recreation and fishing activities, two of the multiple uses of the reservoir (SSRH, 2017). Therefore, even though the object for measures under *Action 5 treats of tourism activity – Environmental Restoration and Preservation Program* – a broader diagnosis in the initial stages of the plan would allow early identification of conflicts in using water and ensuring the goals from Article 1 of the Water Source Areas Act. Furthermore, the proper identification of multiple uses allows determining the relevant social actors for participation and consultation. For example, it is the case for fishers and indigenous peoples, excluded from the decision-making processes, a fact observed in our case study and reiterated by two interviewees, E1 and E2 (ALVES DA SILVA *et al*., 2009).

Moreover, since the Billings Dam falls into Classes 1 and 2 corresponding to more preserved classes, established by the National Environmental Council (CONAMA Resolution No. 357/2005), one of the concerns of the PDPA should be the protection of aquatic communities, which is addressed superficially (MACHADO; KNAPIK; BITENCOURT, 2019). Thus, there is little consideration of regional and local plans and relevant agendas in the region.

In France, SEA plays a vital role in organizing a *consistency analysis* that addresses the compatibility and coherence of the objectives and targets set out in the plans with other sectoral public policies' purposes relevant to the basin territory. This analysis is directly related to the definition of this objective, and it helps to scope which themes should or should not enter into a plan. This analysis from an initial stage guides the scoping in the Sages, identifying synergisms or conflicts that may limit the achievement of the previously defined goals. Moreover, it favours identifying key social actors for the formulation and implementation of the Plan (SANTOS; PIZELLA; SOUZA, 2020).

In this context, one of the strengths of SEA in the Sages is the provision of information on its relationship with relevant sectoral strategies (including national and international environmental protection strategies, especially in Europe), only possible due to the procedures for analysis of consistency (compliance and compatibility) between development objectives, a mandatory procedure in SEAs of Sages (FRANCE, 2015; SANTOS; PIZELLA; SOUZA, 2020).

When associated with a participatory process of identifying the environmental baseline, the consistency analysis allows the contextualization of the plan in the territorial dynamics of the watershed, constituting an opportunity for the establishment of the recommended sectoral and governmental articulations. In addition, in the case of convergent themes, the plan submitted to the SEA can use the information of the diagnoses made by other development plans and programs, avoiding the duplication of data collection and handling (PIZELLA; SOUZA, 2013).

4.2.3 STUDY OF ALTERNATIVES

The main guiding goals of the PDPA-Billings and the APRM Environmental Zoning are focused on phosphorus load and vegetation cover, as determined by the Billings Specific Act. The phosphorus load defined by using MQUAL is a model that correlates soil use and water quality expressed as phosphorus load (SSRH, 2017). The trend analysis brought by the PDPA-Billings included thirteen possible future scenarios of land use and their respective impacts on water bodies and considering the population growth, starting from a baseline scenario without new sanitary infrastructure measures and contemplating situations of phosphorus load reduction according to the actions potentially taken. However, there is a weak connection with development trends of other activities intervening in the watershed environmental quality. As a consequence of this scope limitation, the PDPA does not consider a reasonable set of alternatives to achieve the defined goals. Furthermore, even for the proposed options, no information is presented on their potential negative or positive environmental impacts generated by each of the actions proposed in the PDPA.

It is worth noting that the PDPA study of scenarios provides an essential basis for zoning regarding the appropriate urban parameters for each zone, which is a vital link between the PDPA and the territorial planning that is under the responsibility of municipalities. Thus, the PDPA offers an essential contribution in defining regional guidelines created in dialogue with municipalities. Furthermore, there is also a norm to guide the regional-local compatibilization (Joint Resolution SMA/SSRH No. 01/2013). Thus, we understand that the PDPA presents complete scenarios in terms of alternatives for land use.

However, SEA could offer more possibilities for the study of alternatives. For example, in France, SEA inserts the environmental baseline in the Sages elaboration process, contributing to the proposition of a consistent set of other options to avoid and mitigate adverse environmental impacts and maximize positive ones. There is also a comprehensive study on the consequences of the plan's adoption, considering different themes, explaining the positive and negative impacts that may result from its implementation, even taking up the plan's objectives and the consistency analysis presented earlier.

The SEA of the Sages also presents the description of plan impacts on priority areas for biodiversity conservation – NATURA 2000 (SANTOS; PIZELLA; SOUZA, 2020), and can evaluate the effects of the plan on topics of interest identified throughout the planning process.

4.2.4 SYNTHESIS

Table 1 presents a synthesis of the findings for the context of the PDPA-Billings, practices related to the use of SEA in France, and the contributions identified in the present study.

Table 1 | Potential contributions from SEA applied to water management in France to the PDPA-Billings

Practices identified in PDPA-Billings	*SEA practices in water management in France*	*Contributions*
As for the PDPA's objectives: Focus on **objectives** related to water quality (phosphorus load and vegetation cover).	• Integration of strategic sustainability objectives in context; • Articulation of the Sages' goals with the regional objectives of water quality and previous sectoral decisions.	• Insertion of other strategic objectives for the restoration of the environmental quality of the watershed.
As for the PDPA's **scope**: • Scenario analysis restricted to aspects of land use and capacity of sewage treatment systems; • Water use conflicts not highlighted; • Absence of studies on fishing, tourism, water security; • It does not consider water security, climate change, and biodiversity issues.	• Identification of existing water use conflicts; • Analysis of sustainability key issues in Sage's region; • It considers the impacts of climate change and threats to water security; • It seeks the resolution of conflicts involving social actors that intervene in the water quality.	• More strategic and sustainability-oriented approach; • Mapping of key social actors to the achievement of the defined goals; • Identification of a set of environmental indicators considering conflicts; • Focus on key issues for inducing uses and activities compatible with the conservation and restoration of environmental quality in the watershed.
As for the PDPA **study of alternatives and impact analysis**: • Scenario analysis focused on land use and respective impacts on water quality; • Absence of environmental impact assessment of the proposed options.	• Identification of the potential effects and mitigation measures; • Analysis of the impact of Sage on the Natura 2000 (biodiversity).	• Proposal of programs and actions capable of reaching the goals with more significant environmental benefits for multiple topics.

Source: Prepared by the authors.

5 DISCUSSION

Water management in water source areas requires a comprehensive approach integrating socio-environmental issues and articulating basic sanitation actions, including solid waste management and drainage, biodiversity protection, and housing issues, especially in scenarios of extensive irregular occupation as observed in the Billings Reservoir watershed. In this sense, SEA has proved to be an essential reference to guide decision-making aimed at integrating environmental issues (FRANCE, 2015; GULLÓN, 2005; MONTEIRO *et al*., 2018). When analyzing the PDPA-Billings compared to French practices, we identified possibilities in this research to broaden the definition of the objectives, scoping, and the study of alternatives.

Concerning the protection of water sources, it is evident that the PDPA is a crucial instrument to combine territorial and water resource planning, fulfilling a limitation of the PBH of Alto Tietê when promoting dialogue among different planning scales (SANTOS *et al*., 2020). The PDPA shows itself

exactly as an instrument capable of creating connections that did not exist in the relationship between the basin plans and other plannings (SANTOS *et al*., 2020). We can say that the plan also can induce institutional and intersectoral integration as the PDPA explores land use issues relevant to environmental protection building solutions along with agents involved in sanitation and housing policies, especially in municipalities responsible for the development of zoning.

However, this potential can be broader. For example, a plan with a "development" in its name could advance more deeply in the appropriation of the different strategic objectives for the watershed and the multiple uses of water. By contrast, the plan's text makes a detailed analysis of the unfavourable economic scenario for the development of the planned actions and advances in pointing out possible ways to overcome these limitations, thus progressing the assessment of essential governance issues. Unfortunately, as pointed out, it has been observed during this research that the PDPA-Billings has not been systematically implemented and does not have an organized follow-up process since it has no supervision, monitoring, and structured information system available. This fact certainly limits the planning and management process in the APRM-Billings.

We recognize, in this sense, that the contributions identified to the PDPA-Billings based on SEA would only have meaning in a governance structure in which there is interest in further potentiating the integrating role that the PDPA can fulfil. However, as Monteiro and Partidário (2017) state, any SEA is nested in a specific cultural context of decision-making, which shapes its content. Therefore, SEA is also a political instrument linked to the governance context in which it is inserted.

SEA in the French context proves to be an essential instrument in verifying the connection and the compatibility among different planning initiatives, including transnational guidelines, defined in the WFD, to plans at different scales and sectors (FRANCE, 2015; SANTOS; PIZELLA; SOUZA, 2020). SEA is vital in this practice, and it contributes to ensuring environmental protection principles, guidelines, and actions from legal texts and plans to implementation. A planning and management system in which sectoral and territorial plans and activities are interrelated also allows better control and clarity over the responsibilities of the agents involved in executing the planned actions. Thus, SEA alone in its content is certainly not a determining element for the effectiveness of plans results; it is an evaluation instrument that fulfils an improvement role in a planning system (MONTEIRO; PARTISAN; MEULEMAN, 2018).

We identified that the PDPA-Billings could advance in defining strategic objectives, studies on multiple uses and studies of alternatives. We understand that the PDPA-Billings can be a crucial regional planning instrument focused on the region's sustainability. Expanding objectives, scope, and analysis of other options, as suggested in the results, would mean including topics such as water security, climate change, and multiple uses, contemplating strategies with possibilities for the economic development of the region in alternatives compatible with the preservation of the water source area.

As for the limitations of the research, we consider that the recommendations presented here definitely need to be widely debated by the different social actors of the APRM-Billings. Still, they are a way to show the untapped potential supported in the French practice. We recognize that the PDPA-Billings focusses on the main problems of the watershed, which are the deficiency of basic sanitation and territorial planning; and, even limited to these themes, we still do not see the expected results in water quality, as highlighted by the interviewee E3. This suggests a limited institutional capacity to execute the plan so that strengthening studies in the planning phase would not necessarily improve practical actions.

SEA has been applied heterogeneously in Brazil, with difficulties in advancing institutionally (MALVESTIO; MONTAÑO, 2019; TSHIBANGU; MONTAÑO, 2019). Nevertheless, we understand that the recommendations derived from this work do not depend on SEA regulations and could represent good practices in developing future PDPAs, beyond the context of the Billings Reservoir watershed.

6 CONCLUSION

The PDPA is a vital planning instrument in the context of water management in the state of São Paulo since it allows to outline characteristics, potential, and demands of watersheds that are or can be used as water supply sources, defined as APRMs. We have sought to identify contributions to the PDPA-Billings, based on the analysis of SEA in the French water management system. It is the leading environmental policy instrument used to support and improve plans such as the PDPA to consider environmental or sustainability issues.

We have explored three potential contributions. The first one deals with the definition of the objectives of the plan. In the case of PDPA-Billings, we have observed that there is no explicit definition of an objective, nor clear connections with other objectives of other water resources plans, nor with planning from different sectors, highlighting, in particular, the absence of the theme of climate change. Therefore, in France, SEA can assist the water plans, Sages, and SDAGEs to identify environmental issues contemplated in the elaboration of these plans, facilitating the integration of goals, for example, for biodiversity and climate change into water plans.

The second theme explored stems from the first and deals with the scoping stage to a certain extent. The PDPA-Billings focuses on water quality for supply and addresses little of the multiple water use in the reservoir. In France, the scope definition includes identifying the compatibility among different policies and planning, with identification of conflicts and key actors, which also allows better inclusion of society in participatory processes during the preparation of plans. Finally, we have identified that the PDPA-Billings presents a fascinating comparative study between land use scenarios, but that could be expanded and complemented, especially with the exploration of strategic alternatives for socio-economic development in the watershed and a study evaluating the impacts in each scenario.

We consider that the PDPA promotes an essential connection between water and territorial plans, sanitation, and housing, bridging a gap that the basin plan, the PBH Alto Tietê, did not comply with and is essential for the restoration of environmental quality in the watershed (SANTOS; PIZELLA; SOUZA, 2020).

However, the plan's implementation was slow, and little information has been available so far. We emphasize here that the French context has SEA consolidated as part of a planning system in which there is already greater integration among policies, plans, and programs, favouring the strategic character of water resource plans in the definition of objectives, scope, and alternatives. This highlights the need for a more in-depth study of governance in the APRM-Billings context, beyond the contributions of SEA, demonstrating the obstacles and potentials for planning and management in this context.

Finally, we understand the practices of SEA highlighted here can be helpful in the context of PDPAs even without a regulated instrument in Brazil. In this work, we merely explore three potential contributions from SEA, but other contributions from the different contexts have a use for future studies. Therefore, we recommend future research both to examine the themes already addressed here and to explore new themes, especially the public participation, the definition of recommendations, mitigation of adverse impacts, enhancement of positive impacts, and the follow-up stage.

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