

# CLIMATE CHANGE ADAPTATION AND ‘NO REGRETS’ ACTIONS WITH THE POTENTIAL FOR A POSITIVE MULTIDIMENSIONAL EFFECT: THE CASE OF WATER RESOURCES IN THE METROPOLITAN REGION OF VALE DO PARAÍBA

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## ABSTRACT

In view of the climate models adopted by the IPCC and the INPE that predict negative climate change impacts on water resources in the Metropolitan Region of Vale do Paraíba (RMVP), this research intends to analyze the legal-normative framework related to climate change adaptation from the perspective of municipal legislative and material competence. The objective is to identify climate change impacts on water resources, demonstrate how adaptation can be associated with the realization of matters of local interest that have a positive social, economic and environmental impact, and exemplify current regulations. As a means of investigation, the deductive method and documental research were adopted. Furthermore, the research has a basic nature and an exploratory objective. As a result, the research concluded that municipalities must play an important role in adapting water resources to climate change, especially in ‘no regrets’ measures. It was even possible to exemplify regulations in force in RMVP municipalities, related to: urban supply, protection and conservation of water producing areas, water quality monitoring, sewage

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collection and treatment, management and security of water resources, integrated planning and rationalization of use.

**Keywords:** 'no regrets' actions; climate change adaptation; local governance; water resources.

**ADAPTAÇÃO ÀS MUDANÇAS CLIMÁTICAS E AÇÕES  
"NO REGRETS" COM POTENCIAL DE EFEITO POSITIVO  
MULTIDIMENSIONAL: O CASO DOS RECURSOS HÍDRICOS  
NA REGIÃO METROPOLITANA DO VALE DO PARAÍBA**

**RESUMO**

*Diante dos modelos climáticos adotados pelo IPCC e pelo INPE que preveem impactos negativos das mudanças climáticas sobre os recursos hídricos da Região Metropolitana do Vale do Paraíba, esta pesquisa propõe-se analisar o arcabouço jurídico-normativo relacionado à adaptação das mudanças climáticas sob a perspectiva da competência legislativa e material municipal. O objetivo é identificar os impactos das mudanças climáticas nos recursos hídricos, demonstrar como a adaptação pode ser associada à realização de assuntos de interesse local que causam impacto social, econômico e ambiental positivo, e exemplificar as normas vigentes. Como meio de investigação, foi adotado o método dedutivo e a pesquisa documental. No mais, a pesquisa apresenta natureza básica e objetivo exploratório. Como resultado, a pesquisa concluiu que importante papel da adaptação dos recursos hídricos às mudanças climáticas há de ser desempenhado pelos municípios, sobretudo em medidas no regrets, e, inclusive, foi possível exemplificar normas vigentes nos municípios da RMVP, relacionadas a: abastecimento urbano, proteção e conservação de áreas produtoras de água, monitoramento da qualidade da água, coleta e tratamento de esgoto, gestão e segurança dos recursos hídricos, planejamento integrado e racionalização do uso.*

**Palavras-chave:** ações no regrets; adaptação às mudanças climáticas; governança local; recursos hídricos.

## INTRODUCTION

At least since 1979, the possibility of human interference in the climate system has been treated in a thematic-institutional way by the international community, with concern not only with its causes, but also with the foreseen effects and the necessary adaptation measures to reduce or lessen the potential damage. The Intergovernmental Panel on Climate Change (IPCC), created with the aim of producing scientific content on climate change for policy-makers and decision-makers, recognizes the potential impact of projected changes to water resources.

IPCC studies and models for generating regional climate scenarios carried out by the National Institute for Special Research (INPE) identified the possibility of altering the rainfall history for the Vale do Paraíba region, located in the state of São Paulo, in order to impact the metropolitan region formed there. Although the data are not all convergent, the impact of this risk must be considered when making political decisions, including municipal ones.

The possibility of making adaptations to avoid or mitigate non-stationary interference with the climate system, and the possibility of measures known as ‘no regrets’ to be implemented with a view to improving the municipalities’ structural conditions, assuming the responsibilities arising from their own competencies, provide an opportunity to adopt these transversal adaptation demands. In other words, the exercise of municipal powers, with a view to improving social, economic and environmental conditions, allow for the adoption of adaptation measures as a secondary objective, but which are not, nevertheless, unnecessary.

The exercise of governance of water resources by municipalities, therefore, would have the potential to mitigate the climate change effects, due to the transversality of adaptive actions that converge to the public interest through positive, satisfactory and justifiable results, arising from its implementation.

In this sense, the aim here is to analyze the legal-normative framework related to climate change adaptation, in terms of municipal legislative and material competence, and its political possibilities in urban supply, protection and conservation of water producing areas, water quality monitoring, sewage collection and treatment, safety of water resources, integrated planning and rationalization of use, identifying normative examples in the Metropolitan Region of Vale do Paraíba and North Coast.

To this end, the research was developed in three sections. In the first one, the three main international standards on climate change will be addressed and the effects of their internalization in the Brazilian legal framework referring to water resources will be demonstrated. It will also address the possible climate change impacts on water resources in the state of São Paulo and the Metropolitan Region of São José dos Campos. Therefore, we intend to establish a brief historicity of the theme of climate change and its standards, and to substantiate the perspective of adaptation in view of the possible climate change impacts, demonstrating the need for a transversal integration of the climate variable in water resources- related public policies.

In the following section, the legal framework for climate change adaptation at the federal and state levels of São Paulo will be established, demonstrating the normative recognition of the importance of transversality of adaptation standards and the precept's effectiveness in influencing other standards that may be related to it. From another angle, it will be demonstrated the existence of a verticality of the adaptation standards characterized by the descending influence from the federal to the state and municipal standard and from the state to the municipal standard.

Finally, in the third and last section, the convenience of combining water resources adaptation and governance actions with related municipal competences will be addressed. In this sense, it is intended to demonstrate and exemplify how the ability to interfere in the non-stationary climate system and the measures called 'no regrets' are relevant to the municipalities' competence to provide climate change adaptation measures. Intrinsic to the proposal, the theme of climate governance was also used as a basis for the research. On these bases, the main public policies adopted by the municipalities of the Metropolitan Region will be analyzed from two major perspectives: urban supply and water resources management and security.

To this end, the deductive method and documental research were adopted as a means of investigation. The research has a basic nature and exploratory objective, and intends to contribute to knowledge advancement related to adaptation of water resources to climate change.

## **1 IMPACTS OF CLIMATE CHANGE ON WATER RESOURCES**

The vulnerability of natural cycles has been the subject of studies since the First World Climate Conference, held by the World Meteorological

Organization, in 1979, being the basis for later events, such as the Vienna Conference for the Protection of the Ozone Layer and the Villach Conference, fundamental for the creation of the IPCC (Intergovernmental Panel on Climate Change).

The first report produced by the Intergovernmental Panel indicated the possibility that there was a limited natural absorption capacity for greenhouse gases and that anthropogenic emissions – those resulting from human activities – were likely to be responsible for the progressive and continuous increase in the concentration of those gases in the atmosphere.

With the scientific evidence raised by the IPCC, the United Nations General Assembly established an Intergovernmental Committee to prepare the text of a Framework Convention on Climate Change. This text was eventually adopted on May 9, 1992, at the Earth Summit held in Rio de Janeiro.

The Framework Convention aimed to stabilize the concentration of greenhouse gases in the atmosphere at a level that would rule out the possibility of anthropic interference of negative relevance in the global climate system. However, considering that the effects of climate change would tend to occur due to the cumulative and lifetime of gases in the atmosphere<sup>3</sup>, the Convention establishes that the Parties must, *inter alia*, cooperate in adapting<sup>4</sup> to the climate change impacts, in addition to developing and preparing adequate and integrated plans for water resources management.

In the same sense, and linked to the Convention, the Kyoto Protocol approved the establishment of quantified commitments to limit and reduce emissions for developed Parties and encouraged climate change adaptation effects. In turn, the most recent agreement, signed in Paris, reinforces the terms with a view to strengthening commitments and the capacity to adapt to the negative climate change effects.

Borges (2021) observes that the structural transformation intended with instruments provided for in the Paris Agreement requires an effort to integrate the climate variable across practically all public policies

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3 Regarding the terminology used in the standards and base studies, the concept used by the IPCC for climate change refers to changes in the average or variability of climate properties over a period of time, either as a result of a natural condition or as a result of human activity; in the Framework Convention the concept refers to “a change of climate which is attributed directly or indirectly to human activity” (UN, 1992, art. 1). In order not to cause terminological confusion from the source, the term climate risk as the one caused, directly or indirectly, by any human activities will be used in this work.

4 Concept of adaptation according to IPCC: “relates to the process of adjustment of natural and human systems to the behavior of the climate in the present and in the future. In human systems, adaptation seeks to reduce and avoid potential harm; or explore beneficial opportunities arising from climate change (FIELD *et al.*, 2014).

relevant to emissions mitigation. On the other hand, it would be necessary to demand effective action from governments, especially when dealing with legal standards with broad obligations or planning instruments of a programmatic nature.

In these terms, it would be up to the interpreters and enforcers of the legal climate standards the role of making standards and political commitments effective, through instruments capable of controlling and reducing emissions, in addition to policies and actions that deal with the adaptation of some effects.

In Brazil, adaptation plans and sectoral plans are necessary parts of water resources governance and reflect, directly or indirectly, the possible impact of climate change on the rainfall regime. This is because, for Brazil, and applicable to the state of São Paulo, the IPCC predicts the possibility of an increase in water availability for the Southeast region of South America (PARRY *et al.*, 2007) and a decrease for the North region.

As described in the National Adaptation Plan, the National Institute for Space Research (INPE) developed a model to generate regional climate scenarios for climate change, thus detailing two global climate models, the English HadGEM2-ES and the Japanese MIROC5 (BRASIL, 2016). As an example result, in the period between 2011 and 2100, it was possible to identify the possibility of an increase in the average temperature in the state of São Paulo, both in summer and in winter, in all projections. A decrease in precipitation was also predicted in most of the analyses. In this sense, it is worth mentioning the information contained in said Plan:

It is noted that the centers of maximum rainfall reduction during the summer are positioned over the Midwest and Southeast, in areas under the influence of the South Atlantic Convergence Zone (SACZ) phenomenon, responsible for rainfall accumulation in the region. The centers of maximum rainfall reduction expand to the Amazon regions (BRASIL, 2016, p. 16).

On the other hand, Rodriguez, in a study for the National Water Agency, mentions that it is premature “to say, from a scientific point of view, that the current situation is caused by climate change. For example, in the specific case of the severe drought of 2014/2015 registered in the region of São Paulo, there are very divergent opinions” (RODRIGUEZ, 2015, p. 9).

The Southeast Region of Brazil, in fact, as stated in the National Adaptation Plan, “is recognized as having low climate predictability” (BRASIL, 2016, p. 16) because it is a transition system, so that, therefore, the scenarios may show variations. Nevertheless, the Plan concludes that:

“Among the four simulations, mixed signals of rainfall changes are found in the territory located between the country’s South and Southeast regions” (BRASIL, 2016, p. 16).

In addition, the ability to interfere in the non-stationary climate system can also be considered as another variable (BRASIL, 2010), which is related to environmental changes caused by human activities. Examples of these interferences are alterations in land use, occupation and change; physical changes in the watershed; withdrawal and/or dumping of water in the hydrographic basin, among others. This capacity to interfere in the non-stationary climate system confers an important amplitude in legislative and material competences that impact even the governance of water resources.

Thus, although the impact of climate change may be permeated with inaccuracies and variables, adaptation measures can and should be evaluated when considering the vulnerabilities and risks to the water security of the system itself, as verified in the National Water Security Plan (PNSH) (BRASIL, 2019). In this sense, the water security index (which varies between maximum, high, medium, low and minimum), created in the PNSH, analyzes the risk, defined by the analysis of danger, exposure and vulnerability in the human, economic, ecosystemic and resilience dimension.

For the Vale do Paraíba Metropolitan Region (RMVP), the water security study identified a high index for the Mantiqueira Center’s Water Resources Management Unit; an index that varies from high to maximum in most of the Paraíba do Sul Nucleus, with the exception of medium-grade areas in the municipalities of Cruzeiro, Guaratinguetá, Jacareí, Piquete and, mainly, São José dos Campos. And, on the North Coast, a high security index was identified only in part of the territory of São Sebastião and Caraguatatuba, being medium, and, in large part, low, in the territories of all cities, and with points with minimum security in Ubatuba (BRASIL, 2021).

It is relevant to mention that the concept of risk used to establish the water security index is the same as defined by the IPCC (FIELD *et al.*, 2014). Vulnerability, one of the elements of risk, is defined by the IPCC as “the propensity or predisposition to be adversely affected” (FIELD *et al.*, 2014, p. 5), which aggregates, *inter alia*, the system’s sensitivity or susceptibility (ability to withstand) and ability to face and/or adapt to conditions (FIELD *et al.*, 2014, p. 5).

It should be noted that the ability to adapt, as a concept and as an

element of vulnerability, is associated with social, environmental, cultural, political, economic, technological and infrastructure conditions (FIELD *et al.*, 2014), so that the condition of underdevelopment is an aggravating factor.

In general, due to the existence of risk, which presupposes a conscious or unconscious danger (GUIDDENS, 2002), the precautionary principle materializes what prudence validates by weighing the potential impact (damage) – in the case extremely relevant for vital consumption, use in agriculture, industry and power generation etc. – and among the actions necessary to ensure water quality and urban and rural supply. In fact, uncertainties are a fundamental element of the precautionary principle, as Machado (2012, p. 107) teaches:

The first question deals with the existence of risk or probability of harm to human beings and nature. Is there scientific certainty or is there scientific uncertainty of the environmental risk? Is there or not unanimity in the specialists' position? Therefore, national and foreign opinions on the matter must be inventoried. Have they reached a position of certainty that there is no environmental hazard? The existence of certainty needs to be demonstrated, because it will rule out a later evaluation phase. In case of certainty of environmental damage, it must be prevented, as recommended by the prevention principle. In case of doubt or uncertainty, prevention should also be acted upon. This is the great innovation of the precautionary principle. Scientific doubt, expressed with reasonable arguments, does not dispense with prevention.

The existence of studies indicating the risk makes up the necessary condition for taking measures to adapt to the risk or to the probability of damage. From the perspective of the cost of prevention measures, which is an element of the precautionary principle (MACHADO, 2012), the adaptation of water resources can be associated with measures necessary for society, as a transversal effect of the measures called 'no regrets' (those whose execution does not cause regret because they produce positive results).

In this sense, Moreira (2021) comments that there is a need for compulsory action by the Government in defense of the environment, and that this should not be seen as something symbolic, which would characterize a theatrical State. This is because the Federal Constitution of 1988 determines the affirmation of this right, in addition to its application, as stipulated in § 1 of art. 225, which lists the Government's specific duties to ensure the effectiveness of the right to an ecologically balanced environment. The author argues that it would be a mandatory state action that "must materialize, among others, in effective preventive measures in the control of

environmental quality, including the defense of climate stability, whose compliance is mandatory” (MOREIRA, 2021, p. 30).

Thus, considering the high probability of climate change, attributed or not to man, and the potential effects of this change on water resources, despite the uncertainties of forecast and the water security index for the RMVP, adaptation actions that are transversal and of the ‘no regrets’ type make it unjustifiable to assume a risk with the potential to cause serious social, economic and environmental impacts. It is worth repeating, above all, that when policies and plans are indirectly associated with demands for climate change adaptation, regardless of whether this occurs, adaptation actions are justifiable as they produce benefits for society.

## **2 VERTICALITY AND TRANSVERSALITY OF ADAPTATION STANDARDS**

At the federal level, the verticality and transversality of climate change adaptation standards can be demonstrated by Law n. 12.187/2009, which establishes the National Policy on Climate Change (PNMC) (BRASIL, 2009), by Decree no. 9,578, which regulates the National Fund on Climate Change, and the National Plan for Climate change adaptation (PNA) (BRASIL, 2016).

In the PNMC, the verticality and transversality of the standards are an express provision contained in art. 3, V: “national actions to face climate change, current, present and future, must consider and integrate the actions promoted at the state and municipal levels by public and private entities” (BRASIL, 2009). On these bases, the aforementioned policy aims, among other claims, at the implementation of measures to promote adaptation by the three governmental spheres, and defines as a guideline, among others, the integrated adaptation strategies at the local, regional and national levels.

In the same sense, the applicability of the provisions of the Policy in public policies and government programs is provided for in art. 11 of the PNMC: “the principles, objectives, guidelines and instruments of public policies and government programs must be compatible with the principles, objectives, guidelines and instruments of this National Policy on Climate Change” (BRASIL, 2009).

In general terms, scientists and scholars have been using systems theory to explain facts that occur in the universe, thinking in terms of

connectedness, relationships and context. So, the right to a balanced environment, as a fundamental human right, can be understood in those senses, since the question of this right's effectiveness involves society's various spheres, which are mutually related. Therefore, several aspects must be analyzed to obtain a better understanding and solutions proposals for potential problems (BIANCHI, 2010).

In this case, an example of PNMC's transversality in the decree that regulates the National Fund on Climate Change resides in art. 5, which establishes "to ensure resources to support projects or studies and to finance ventures aimed at mitigating climate change and adapting to climate change and its effects" (BRASIL, 2009), and to ensure that resources can be allocated to adaptation projects in basic sanitation, water supply and sewage sanitation.

Finally, the PNA established verticality by providing for the implementation by the Federal Government, in cooperation with other federative entities and non-governmental entities, and transversality to achieve its objectives. In these terms, the PNA presents an integrated strategy for management of the negative risks of climate change, and the transversalization of objectives and goals is established on what it defines as principles: (1) to institute a vertical governance of adaptation guidelines and measures; (2) to institute horizontal governance in the establishment of "adaptation responses" (BRASIL, 2016, p. 19); (3) "approach adaptation in a sectoral and thematic way and, when applicable, in a territorial way" (BRASIL, 2016, p. 19); (4) to implement adaptation with a view to producing co-benefits.

The general objectives of the PNA are defined as the integration of risk management and development strategies, influencing the various federative entities' governmental policies. As specific objectives, the PNA establishes the dissemination of knowledge and information; the promotion of cooperation and coordination between bodies for risk management; and identification and promotion of climate change risk adaptation measures.

In order to achieve these specific objectives, separate goals are established by Sectoral and Thematic Strategy. Those related to water resources are under the auspices of the National Water Agency for the development of integrated climatic and hydrological models, and for the incorporation of adaptation measures, expressly mentioning those conceptualized as 'no regrets' (BRASIL, 2016).

At the state level of São Paulo, verticality and transversality are provided for in Law no. 13,798/2009, which establishes the State Policy

on Climate Change (PEMC). It contains the objective of implementing measures to prevent and adapt to climate change, and the guideline for regional adaptation planning and cooperation in prevention and adaptation (SÃO PAULO, 2009b).

It is interesting to mention that the verticality present in the PEMC can influence the municipal area in relation to the disciplining of urban and rural land use, aiming, *inter alia*, to consider the climatic effects in the macro-drainage plans and to influence in the vegetation cover, the legal reserve, permanent preservation areas, forests areas, and riparian forests.

The provision, by the way, is perfectly in line with the municipalities' competence to promote territorial planning due to the concurrent competence of the federal government and states to legislate on soil and natural resources conservation and defense, as well as water resources protection, and because of the interpretation according to the constitution, of environmental protection, as well as urban microclimate protection.

The verticality and transversality of the rules meet the need to decentralize adaptation efforts without losing management capacity. On the demands that adaptation requires, Bulkeley and Tuts (2013, p. 648) comment:

By this account, any form of response to climatic impacts might be regarded as adaptation. However, the literature suggests that an important distinction can be drawn between those responses through which individuals and communities 'cope' with climatic (and other) risks, and adaptation. While coping involves "existing strategies that are used by urban residents to respond to climate variability and other threats" (Dodman *et al.* 2011. p. 6), adaptation requires more explicit deliberation on and efforts to change the practices and institutions through which risks are mediated and responses are framed.

Thus, the efforts that adaptation requires, of explicit deliberation, of efforts to change practices and institutions and of structured responses are satisfied in Brazil and in the state of São Paulo, including in relation to water resources.

### **3 CONFLUENCE OF ADAPTATION AND WATER RESOURCE GOVERNANCE ACTIONS: CONVENIENCE OF RELATED ACTIONS**

At the municipal level, legislative and material competence related to adaptation to climate change impacts on water resources lies beyond what

is constitutionally designated as within its competence. In other words, the legislative and material competence related to the issue goes beyond the constitutional wording due to the transversality of the matter and the possibility of relating to demands that can be characterized as 'no regrets' and the capacity to interfere in the non-stationary climate system. These perspectives, by the way, have often been adopted in developed countries, explain Hunt and Watkiss (2011, p. 39):

In developed countries, there are now examples where city authorities have undertaken multi-sectoral analysis of potential climate change impacts. [...] The focus on these impact categories also reflects the areas where public infrastructure is currently under most pressure from socio-economic development. It also reflects areas where there is greatest sensitivity to current climate variability. This pattern is important in determining economically effective adaptation, recognising that an effective adaptation measure to future climate change may also reduce vulnerability with respect to current climate variability (Fankhauser, 2006). Use of data relating to historical extreme weather events, and their changing frequencies under climate futures, are increasingly used to quantify these risks.

In Brazil, in turn, the theme "environmental governance" came to the fore with the Rio+20 Conference, as an object of analysis at different federative levels. Moura and Bezerra (2016, p. 91) understand that

[...] a reductive vision has led to the analysis of only the environmental sector's legal, institutional and managerial framework, extending, at most, to plans and initiatives to achieve environmental quality, as a result of the action of a single sector of the State and of society, the environmental one.

However, governance that promotes sustainable development should be seen as the ability to insert the idea of sustainability into the set of public policies and their interrelationships.

In this sense, a sustainable society or a project that involves sustainability must strive for development in several areas. Here, Morin and Kern (1995, p. 95) – dealing with the currently widespread notion of development – warn that "the development notion, as it was imposed, obeys the artificial machine's logic. It is believed to rationalize society in favor of man, man is rationalized in order to adapt him to society's rationalization". Another important issue to be highlighted is not to confuse governance with governability, which, according to Weiss (2016, p. 329):

*Governability* is defined by the rules and conditions under which power is exercised; it depends on the dynamic balance between the level of societal demands and the public and private institutional system's capacity to process them. It consists of

the relationship between three components: problems, ability to face them, and achievements. *Governance* is the ability to transform the governmental act into public action; it results from the sum of the different ways in which people and institutions, public and private, manage their common affairs, through ongoing processes that accommodate conflicting interests.

The author also explains that, in terms of governance, “the level of articulation and the ability to act depend on the actors, formal institutions and informal arrangements involved and their decision processes” (WEISS, 2016, p. 329).

Still in terms of governance, it is worth mentioning the one related to transnational climate. According to Hale and Roger (2014), the standard multilateral approach to global environmental governance has become limited due to climate change. A number of scholars and practitioners develop alternative or auxiliary approaches to mitigating the climate change effects. Some continue to emphasize state-based multilateral negotiations; and others, in contrast, shift attention to transnational climate governance carried out by cities, NGOs, corporations and other sub- and non-state actors.

In this context emerges the term orchestration, which mixes these logics and, therefore, represents a new way of thinking about solutions to problems of collective action in global politics, represents another example of how new forms of governance can transform “traditional” institutions’ nature and behavior, rather than simply replacing them. Orchestration can be defined as a strategy through which States or International Organizations bring new capacities and resources to the provision of global public goods, strengthening or catalyzing transnational governance schemes (HALE; ROGER, 2014).

From another angle, in Brazil, a problem normally raised in terms of governance is the lack of financial resources, especially within municipalities, where direct investment in water resources adaptation may not be the most attractive option as compared to the indirect possibility. However, the exercise of municipal governance can produce positive, satisfactory, necessary and justifiable results. Material competences, related to environmental health, protection and preservation, combating pollution, basic sanitation and legislative competences, such as territorial ordering by planning and control of land use, parceling and occupation, give the municipality breadth in the governance of water resources.

As an example, and a paradigmatic case, Municipal Law of São Paulo

no. 14,933/2009, which institutes the Climate Change Policy, establishes strategies for mitigation and adaptation in waste management and land use, and prescribes the duty to implement a program for water sources recovery and protection; establishes the conservation and fight against waste of water; and encourages the standardization of payments for environmental services (SÃO PAULO, 2009a).

Another paradigmatic case also from São Paulo, Law no. 17.104/2019, stands out for instituting a water security and water management policy, which, in addition to establishing a deadline for the formulation of a report on the situation on water security in the municipality, designates the transversality of the matter by relating it to the definition of a policy of sanitation, revitalization and protection of water bodies, civil defense and climate change adaptation. It also points out the relationship between public health and water quality (SÃO PAULO, 2019).

This association of policies and plans strengthens and publicizes the understanding that water supply security has a link of relative dependence with other public policies. The pretension of adapting to the possible climate change impacts on water resources remains, therefore, justified in investments aimed at improving the quality indices of these areas of influence, falling back on the aforementioned 'no regrets' actions.

In the Vale do Paraíba Metropolitan Region, although the municipalities do not have a climate change policy or a water security policy like the one in the municipality of São Paulo, the present study will focus on those involved in the theme of water resources in (1) urban supply, protection and conservation of water producing areas, water quality monitoring, sewage collection and treatment; and (2) water resources management and security, integrated planning and rationalization of use.

### 3.1 Urban supply

In terms of urban supply, the protection, conservation and revitalization of water-producing areas; the adoption of a water quality monitoring and control system; and sewage collection and treatment can be highlighted as objects of actions of legislative competence and municipal material. It is important to mention that protection and restoration of water-related environments is associated not only with the provision of a social and environmental nature, guaranteeing the essentials for life, but also with the economic aspect, in rural and industrial supply, and specifically in the Vale

do Paraíba region, in the operation and generation of income from hydroelectric plants.

As a normative example, Complementary Law no. 3, of 2006, of Pindamonhangaba, establishes as objectives of the municipal planning and management policy the preservation of natural resources and springs with protection, conservation and recovery of water courses, springs, permanent protection areas and riparian forests (PINDAMONHANGABA, 2006).

It is also interesting to note Law no. 421/2006 of the municipality of Ilhabela, which provides for the Social and Environmental Development Master Plan, and establishes the Environmental Protection and Qualification program, which involves, among others: recovery of riparian forests; implantation of conservation units; monitoring of continental and marine waters; recovery and decontamination of water courses (ILHABELA, 2006).

Regarding the water quality monitoring and control system, some legal standards were adopted by the metropolitan region municipalities with a view to guaranteeing supply, environmental quality and monitoring of possible negative climate change effects on resources and on the water security of their areas of competence.

In this sense, it is interesting to highlight Complementary Law of Pindamonhangaba, no. 3, of October 10, 2006, which aims to ensure the safety of water resources and establishes the need for the Neighborhood Impact Study to portray any possible impact related to it (PINDAMONHANGABA, 2006).

Of note too, in Ilhabela, Law no. 291, of 1988, relates water quality to environmental quality, very relevant to local characteristics. The standard institutes measures to support the quality of water resources in order to prevent environmental degradation from having a negative influence on the quality of life, on sand pollution and on bathing in the archipelago (ILHABELA, 1988).

Finally, sanitary sewage collection and treatment is related to climate change due to the potential to aggravate a situation of water supply vulnerability caused by climate change. This is because the increase in sewage concentration, caused by the decrease in water resources and, consequently, the decrease in the dilution capacity, will tend to increase costs or even make water treatment unfeasible.

The relationship between sanitary sewage and water quality, public health and ecosystems conservation, and also these relationships with the

vulnerability of supply caused by climate change, can be exemplified with the cities of Aparecida, Cruzeiro, Guaratinguetá, and Queluz. These cities, according to the National Sanitation Information System (BRASIL, 2020b), have low rates of sewage treatment and have a permit to use the Paraíba do Sul River for sanitary sewage (SIGA-CEIVAP, 2022). Thus, the aforementioned cities discharge their sewage into the same river that serves, for others, as a source of public water supply.

The use of the same river for sewage disposal and for public supply demonstrates how the expansion of the sewage collection network and its treatment can be a clear example of a 'no regrets' measure. If, for climate change adaptation, the improvement of the quality of water resources, with reduction of the pollutant load and treatment costs and the increase of water availability are relevant, on the other hand, they are beneficial for society in addition to tending to improve the local population's health.

### **3.2 Water resources management and security**

Having highlighted the standards related to elements that constitute urban supply, according to the parceling adopted in this article, it is convenient to do the same in relation to water resources management and security. In these terms, we highlight the integrated planning of water resources in making the matter compatible in the plans, policies and management of related matters, and the rationalization and reduction of losses.

In terms of regulations, as previously mentioned, the PNMC provides for the compatibility of climate change with public policies and government programs. The PEMC foresees the integrated evaluation of human actions and public and private policies, plans and programs. In the sense of this transversality, it is worth highlighting the influence that the Hydrographic Basin Plans must exert as guidelines for municipal master plans.

As an example of municipal legislation that deals with water resources in an integrated planning, Complementary Law no. 612/2018, of São José dos Campos, prescribes rules for land use and occupation for the Jaguari Basin's region of influence, an important area for water supply, including the Metropolitan Region of São Paulo. This law establishes the Municipal Environmental Policy Guidelines, which, among other things, provides for the identification of areas of water relevance that are vulnerable, aiming at territorial organization (SÃO JOSÉ DOS CAMPOS, 2018).

Complementary Law no. 612/2018 also recognizes the transversality

of environmental matters and the need to articulate and make this plan compatible with other policies, plans and strategies. Specifically on water resources, it is possible to identify this forecast in the Municipal Basic Sanitation Plan, which recognizes the gain in the quality of water resources in the municipality (SÃO JOSÉ DOS CAMPOS, 2018). It is also interesting to mention the possibility of environmental compensation in the restoration of riparian forests to guarantee and secure water production.

Also noteworthy is Law no. 2,737/2003 of the municipality of Campos do Jordão, which establishes the mapping of water resources and watersheds in the municipality and institutes a program to prevent the use and application of pesticides and agricultural fertilizers in areas of influence of water resources, in order to avoid contamination as well as the management of pastures close to water courses (CAMPOS DO JORDÃO, 2003).

Regarding rationalization of use and reduction of losses, it is pertinent to highlight Municipal Law no. 9,235/2014, of São José dos Campos, which establishes drinking water waste control under four axes: inspection of water waste by citizens; water loss control programs; information, environmental education and raising population awareness; adoption of techniques and equipment to reduce water consumption in hydraulic projects for municipal assets (SÃO JOSÉ DOS CAMPOS, 2014).

The importance of these legislations becomes more evident when the water loss figures are analyzed. According to National Sanitation Information System data, the waste that occurs between distribution and delivery of water to the consumer in the cities of Aparecida, Cruzeiro, Guaratinguetá, Lorena, Natividade da Serra, Piquete and Santa Branca is greater than the national rate of 39 % (BRASIL, 2020a), that is, in said cities, more than 39% of the water is lost between distribution and delivery to the consumer.

Regarding municipal governance of water resources in terms of adaptation to climatic events, it is possible to highlight Complementary Law no. 612/2018, of São José dos Campos, which recognizes the environmental protection area of the Paraíba do Sul and Jaguari rivers for climate change adaptation, in addition to the municipality's environmental policy guidelines for establishing the policy and municipal plan for climate change adaptation (SÃO JOSÉ DOS CAMPOS, 2018). It is also relevant to highlight Law no. 743/2009 of the municipality of Ilhabela, which deals with addressing climate change and hydrological risk as a fundamental objective of environmental education (ILHABELA, 2009).

## CONCLUSION

In this research, the legal-normative framework related to climate change adaptation was analyzed from the perspective of municipal legislative and material competence, and its political possibilities in urban supply, protection and conservation of water producing areas, monitoring of water quality, collection and sewage treatment, security of water resources, integrated planning and rationalization of use; especially with the identification of normative examples in the Metropolitan region of Vale do Paraíba and the North Coast.

From the survey, it was possible to identify the climate change impacts on water resources, to demonstrate how adaptation can be associated with the realization of local interest matters that cause a positive social, economic and environmental impact, and exemplify the current regulations.

It has been shown that the climate models adopted by the IPCC and the INPE predict negative climate change impacts on water resources in the São José dos Campos Metropolitan Region, and that, although not all data converge to this conclusion, vulnerability and risk to water security must be considered because, above all, they are documented by official institutions. Prudent action and prevention-based action are, therefore, grounded in these reasons, and in others, which can meet social, economic and environmental demands.

The municipalities' legislative and material competence on the matter were analyzed due to the verticality of the adaptation standards, embodied in the National Policy on Climate Change, in the National Adaptation Plan and in the State Plans of São Paulo, and in the demonstrated transversality that involves issues directly or indirectly related to it in socio-environmental, political, economic and infrastructure relations. Verticality and transversality represent true integrated management strategies, aimed at meeting objectives and goals.

Verticality and transversality meet the need to decentralize adaptation efforts without losing management capacity. These are conditions that make environmental management processes effective for a theme that is in fact vertically and transversally integrated and transdisciplinary. Hence the importance of the integrative systematization of standards that deal with climate change adaptation, especially as regards water resources.

However, governance that promotes sustainable development should be thought of as the ability to insert the idea of sustainability into the set

of public policies and their interrelationships. Environmental governance needs to be more articulated and capable of promoting actions within the most varied actors, formal institutions and informal arrangements involved and their decision-making processes. The idea of transnational climate governance by cities, NGOs, companies and other sub- and non-state actors established a context that allowed understanding the importance of “orchestration”.

With this in mind, it is understood that the exercise of municipal governance can produce positive, satisfactory, necessary and justifiable results. This is because material competences, related to health care, protection and preservation of the environment, combating pollution, basic sanitation, and legislative competences, such as territorial ordering for planning and control of land use, parceling and occupation, give the municipality breadth in the governance of water resources, both for the so-called no regrets measures and to avoid interference in the non-stationary climate system.

Regarding the standards, although the Vale do Paraíba Metropolitan Region municipalities do not have a climate change policy or a water security policy of relevance and as an express objective, such as the city of São Paulo’s, it was possible to highlight laws that exemplify how a chain of losses can be reversed into a chain of benefits for society.

In this sense, in terms of urban supply, the protection, conservation and revitalization of water producing areas, the adoption of a water quality monitoring and control system, and the collection and treatment of sewage could be highlighted as objects of municipal legislation geared to adaptation, albeit indirectly, however, with extreme relevance in socio-environmental terms.

The possibility of instituting standards related to legislative competence and municipal material to promote actions of urban supply adaptation to climate change presents itself, therefore, as a broad field as necessary as it is pertinent to local social, economic and environmental development. Adaptation measures, therefore, are largely justified as inherent to benefits for other needs.

Regarding water resources management and security, with emphasis on the integrated planning of these resources and rationalization and losses reduction, it is possible to conclude that the municipalities’ material and legislative competence has a wide field of action in the related matters. It is solely up to the municipalities, although subject to the influence of other entities in competing matters, the possibility of well organizing

the territorial space through the planning and control of urban land use, parceling and occupation, in order to make them compatible with the quality and guarantee of water resources.

Due to the competence to legislate on matters of local interest, the municipalities are open to a wide range of action which largely depends on the perspective of local needs and the creativity to provide solutions. An example of this is the legislation of São José dos Campos on environmental compensation in the restoration of riparian forests to guarantee and secure water production, and the legislation of Campos do Jordão to prevent contamination of water resources by pesticides and agricultural fertilizers.

Thus, municipalities have important attributions for water resources adaptation, either through direct actions, related to the capacity to interfere in the non-stationary climate system, or indirectly, through 'no regrets' measures. However, the challenge of internalizing sustainable criteria within the scope of sectoral public policies to promote changes in development requires a transversal treatment of environmental standards and policies, which need to go beyond their merely corrective and punitive functions, so that, in fact, they subsidize the implementation of sustainable public policies. In this context, social participation and inter-institutional articulation are important basic elements for good municipal environmental governance.

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