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Water Resources and Governance Approaches: Insights for Achieving Water Security

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Abstract: Integrated river basin management (IRBM) has been proposed as a means to achieve water security (WS), maximizing economic and social well-being in an equitable manner and maintaining ecosystem sustainability. IRBM is regulated by a governance process that benefits the participation of different actors and institutions; however, it has been difficult to reach a consensus on what good governance means and which governance perspective is better for achieving it. In this paper, we explore the concept of "good water governance" through the analysis of different governance approaches: experimental (EG), corporate (CG), polycentric (PG), metagovernance (MG) and adaptive (AG) governances. We used the Organisation for Economic Co-operation and Development (OECD) water governance dimensions (effectiveness, efficiency and trust and engagement) as a "good enough water governance" that regards water governance as a process rather than an end in itself. Results indicate that each of the five governance theories presents challenges and opportunities to achieve a good governance process that can be operationalized through IRBM, and we found that these approaches can be adequately integrated if they are combined to overcome the challenges that their exclusive application implies. Our analysis suggests that a combination of AG and MG encompasses the OECD water governance dimensions, in terms of understanding "good enough water governance" as a process and a means to perform IRBM. In order to advance towards WS, the integration of different governance approaches must consider the context-specific nature of the river basin, in relation to its ecologic responses and socioeconomic characteristics.

Keywords: water management; integrated river basin management; water security; good governance

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1. Introduction

The diversity of ecosystem services that freshwater resources provide plays a key role in poverty reduction, economic growth and environmental sustainability [1]. All goods and services consumed by any society come from natural sources of matter and energy [2] and, therefore, economy and human well-being depend on natural systems' integrity [1]. However, the different uses that society exerts on water resources have increased considerably, causing a negative balance for ecosystems [3]. This precipitates the need to ensure water in quantity and quality for aquatic ecosystems as life-sustaining systems and to generate resilience derived from its lack (water shortage or droughts) or excess in short periods (risks due to floods), to promote human and economic development for all the inhabitants of the territory, advancing towards water security (WS) [4].

Grey and Sadoff provide a widespread concept of WS, highlighting the role of water as both a source of threat and a source of services, defining it as "the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments

and economies" [5]. Achieving it depends on the capacity of a society to manage water resources [1,6], regarding the river basin as the appropriate territorial unit [7]. Expanding on this definition, the notion of WS has been addressed in several studies, for instance, quantifying the main threats to freshwater biodiversity from both human and ecosystem perspectives on WS [8], analyzing how WS is conceptualized and operationalized according to different geographical regions and scales [9], and analyzing the relationship between WS and governance [10]. According to these studies, the following ideas emerge: WS is an integrated concept, so water management strategies must jointly address threats to biodiversity and human water securities; water crisis mainly results from governance issues, so an integrative perspective of WS is needed to improve water governance; and, the conceptualization of WS is diverse and context-specific, so it is important to include local communities' perspectives when addressing WS issues in water management.

However, achieving WS is a complex task, since it is a multi-faceted problem that goes beyond simple balancing of water supply and demand [11]. WS focuses not only on positive, but also on negative outcomes for people (water related disasters, water-borne diseases in children, conflicts over water access, supply and/or recreation), economy (hydropower production, irrigated agriculture and economic losses related to disasters), and the environment (ecosystem health, spatial extent of wetlands and estuaries, biodiversity and water quality), which are influenced by water management [12].

The multi-faceted nature of WS also refers to the water-related challenges that the world is currently experiencing. According to the 2021 United Nations World Water Development Report [13], in terms of water availability, over two billion people live in countries experiencing water stress, 1.6 billion people face economic water scarcity (water is physically available but lacks infrastructure to be accessible), and 30% of the largest groundwater systems are being depleted. In terms of water quality, globally, about 80% of industrial waste is discharged into the environment without treatment, and almost all major rivers in Africa, Asia and Latin America are regarded as polluted. In terms of extreme events, between 2009 and 2019, nearly 55,000 deaths were caused by floods around the world, causing US $76.8 billion in economic losses, and droughts affected 100 million people (2000 deaths), causing US $10 billion in economic losses. In relation to water, sanitation and hygiene (WASH), the UN report states that, in 2017, 71% of the global population used a safely managed drinking water service and 45% used safely managed sanitation services; in addition, regarding water-related ecosystem services, 14 of the 18 categories of 'nature's contribution to people' are in detriment, including: regulation of freshwater quantity, coastal and freshwater quality and hazards and extreme events.

WS challenges are likely to become even greater because of climate change. According to the IPCC, an increase in the frequency, intensity and/or amount of heavy precipitation in several regions is expected to occur, with global warming up by 1.5 °C as compared to preindustrial levels, as well as an increase in the frequency and severity of floods and droughts [14]. This implies a water crisis that requires immediate action [15].

Appropriate institutional roles and management instruments are two factors that could help in meeting WS challenges [4]. In this sense, "water crises are often primarily governance crises" [16], since the processes by which decisions are adopted and applied are critical for water resources management. As a governance measure, some authors propose that power and responsibility should be shared between water resource users and state agencies to achieve more collaborative and coordinated actions [17–20]. This can be reached through integrated water resources management (IWRM) that focus on the river basin (also termed watersheds and/or catchments) as the most appropriate spatial unit for management [21]. Consequently, integrated river basin management (IRBM) has arisen as a concept that is designed to assess integrated and multi-resource problems, considering the management of land, water and related natural resources within hydrologic boundaries to achieve long-term sustainability [22,23].

River basins, either independently or when interconnected with others, are considered the most accepted territorial unit for water resources management [22,24–27]. The

concept of a river basin (or watershed) can be defined, from a geological/hydrological perspective, as a topographically traced area drained by a stream system [28]. However, the IRBM concept is holistic, because it considers the relevance of addressing multiple uses of freshwater resources [25] and, therefore, involves different stakeholders' perspectives about the river basin (i.e., industry, irrigation, biodiversity, etc.). In this sense, taking into consideration that WS involves issues of health, livelihoods, ecosystems and production [5], the river basin is not only regarded as a geographical unit, but also as a political and ideological construct that is linked with changing scalar arrangements, in both ecological and regulatory (or governance) terms [29]. However, some studies have questioned its benefits to water management, in some specific cases, related to discrepancies among hydrological and political-administrative boundaries and among the local and higher orders of government [30–33]. In these cases, the concept about the proper unit of analysis must be revised to adequately advance towards WS.

In spite of the above, IRBM should be guided by a water governance system that is inclusive, multi-scalar and sustainable [19,34–36], and should have varied responses to uncertainty caused by the effects of climate change [37,38]. However, there has been no consensus on what the term "water governance" means or the characteristics that should include a "good water governance" system. In this paper, we try to shed light on this topic.

The Organisation for Economic Co-operation and Development (OECD) defines water governance as a process that involves different actors and perspectives in decision-making; it is focused on administrative and institutional dynamics and includes formal and informal organizational aspects [16]. In the academic literature it is possible to find different approaches to governance. For instance, Kooiman and Jentoft address three governance modes: hierarchical, self-governance and co-governance [39]. For their part, Turton et al. briefly analyse three broad types of governance: corporate, network and adaptive governances [40]. Partelow et al. have synthesized and compared eight different governance theories: polycentricity, network governance, multilevel governance, collective action, governmentality, adaptive governance, interactive governance theory and evolutionary governance theory, in terms of their application to coastal systems [41], while Monkelbaan has compared five governance theories: transition theory, metagovernance, polycentricity, network governance and experimentalist governance, in terms of their relevance in achieving sustainable development goals (SDGs) [42].

In this paper, we seek to advance towards an understanding of good water governance, with a focus on the OECD Water Governance Framework, by analyzing five governance approaches: corporate governance, experimentalist governance, polycentric governance, metagovernance and adaptive governance, in terms of addressing the complex task of advancing towards WS. We go further than previous studies on governance classification, arguing that these approaches could, to some degree, include features that suit the OECD water governance dimensions (effectiveness, efficiency and trust and engagement) and can be applied to freshwater systems and IRBM. For this purpose, in Section 2, we provide the theoretical background, analyzing the concept of good governance and the five governance approaches. We highlight the OECD water governance dimensions as a perspective that focuses on water governance as a process rather than an end to achieve, and we analyze these approaches to governance in accordance with their objectives, role of private and public actors and their relationship, leadership and expected outcomes. In Section 3, we assess the strengths and possible failures associated with these approaches to address the OECD framework. Then, we inform possible integration mechanisms to achieve appropriate forms of good water governance (Section 4). In this way, a particular governance approach (or a combination of them) may be more effective in solving particular environmental problems. This latter attribute supports the idea of "good water governance" as a dynamic and context-specific process, that is, a means to achieve WS, which is operationalized through IRBM [43]. We provide our main conclusions in Section 5.

2. Theoretical Background: "Good Water Governance" and Governance Approaches

2.1. Good Water Governance

Advancing towards IRBM depends on an integration of actors, institutional roles and water management instruments, where policies, guidelines and institutions must adequately address the way in which water resources are used, in order to protect the natural adaptive capacity of the ecosystems.

Different authors and international institutions have proposed different indicators or characteristics that help to resolve if governance is being well implemented. For example, the United Nations Asia Pacific Social and Economic Commission (ESCAP) suggests eight key parameters for good governance: it is participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive and follows the rule of law [44]. Likewise, the World Bank developed the Worldwide Governance Indicators (WGI) project, establishing six indicators of good governance, some of which are similar to those of ESCAP: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption [45]. In particular, some specific indicators for good water governance have been proposed by Lautze et al.: openness and transparency, broad participation, predictability and ethics, including integrity (as control of corruption) [43].

According to the definition of water governance cited above, it is worth emphasizing that good governance is a process. This is supported by Grindle, who states that it is important to focus on how to change for the better, increasing the understanding of how institutions emerge, evolve and improve, suggesting moving to a concept of 'good enough governance' [46]. Particularly for water, Ashton states that good governance is a complex and multi-dimensional process guided by a philosophy or set of operating principles that facilitate interaction towards a desired situation or consequence [47]. This interaction is better achieved by the promotion of a trialogue among science, society and governments, who have specific and complementary roles in water management. Both perspectives sustain to some extent what the OECD states, regarding water governance as "a means to an end, not an end in itself" [19].

In relation to the above, a framework that we consider represents the idea of 'good enough water governance' as the one represented by the OECD through the Principles on Water Governance [19]. According to this organization, governance is good if "it can help to solve key water challenges, using a combination of bottom-up and top-down processes while fostering constructive state-society relations". These principles are grouped into three main dimensions: effectiveness, efficiency, and trust and engagement.

Governance must be effective, defining clear, sustainable water policy goals, to implement them and to meet expected targets. Among its principles, we highlight: "clearly allocate and distinguish roles and responsibilities for water policymaking, policy implementation, operational management and regulation, and foster co-ordination across these responsible authorities; encourage policy coherence through effective cross-sectoral co-ordination, especially between policies for water and the environment, health, energy, agriculture, industry, spatial planning and land use; and adapt the level of capacity of responsible authorities to the complexity of water challenges to be met, and to the set of competencies required to carry out their duties".

Governance must be efficient in terms of maximizing the benefits of sustainable water management at the least cost to society. Among its principles, we highlight: "produce, update, and share timely, consistent, comparable and policy-relevant water and water related data and information, and use it to guide, assess and improve water policy; ensure that sound water management regulatory frameworks are effectively implemented and enforced in pursuit of the public interest; and promote the adoption and implementation of innovative water governance practices across responsible authorities, levels of government and relevant stakeholders".

Governance should build trust and engagement, ensuring the inclusion of actors through democratic legitimacy and fairness for society. Among its principles, we highlight:

"promote stakeholder engagement for informed and outcome-oriented contributions to water policy design and implementation; encourage water governance frameworks that help manage trade-offs across water users, rural and urban areas, and generations; and promote regular monitoring and evaluation of water policy and governance where appropriate, share the results with the public and make adjustments when needed".

The complexity of water-related problems has led to the emergence of different governance approaches which, in some way, aim to achieve a 'good enough water governance' process.

2.2. Governance Approaches

2.2.1. Corporate Governance

Corporate governance (CG) is the system by which companies (whether public or private) are directed, governed and controlled, promoting transparency and responsibility between stakeholders that belong to corporations or other types of organizations [48]. The objective of this governance approach is to create a regulatory and operational framework, so that companies, owners and regulators are more transparent, accountable and efficient in the decision-making processes. In this sense, well-governed companies could have lower financial and non-financial costs associated with risks related to WS issues.

In terms of the relationship among actors, company's employees and suppliers take leadership in CG due to their importance in decision-making. They are related to a company that has intrinsic attributes: mission/vision, corporate culture (reflected in its values), nature of its financial structure (capital, incomes, debts and profits) and the sector/industry where it operates. Companies are also affected by other actors: (i) clients/customers demand products/services, including price and quality, and their preferences may be shaped by their attitude towards sustainability; (ii) governments act as regulators of companies' behavior, setting and overseeing the framework in which they operate, such as policies, prices/tariffs, taxes, water allocation, water planning, environmental laws and compliance regimes, among others; (iii) investors (shareholders, lenders and fund managers) provide finance, pursue responsible investment and can have their own systems for information access and verification, in relation to the company's behavior [48].

In the case of water, CG is closely linked to the concept of corporate water stewardship, which, within a IWRM framework, is regarded as "actions by water users themselves to contribute to the management of the shared resource towards public good outcomes" [49]. This concept is related to the role of corporations in water stewardship, which is in turn defined as "the use of water that is socially equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process that involves site and catchment based actions" [50]. In these terms, we understand that an expected outcome of corporate water stewardship is to promote dialogue and collaboration between corporations and water users to achieve WS. Therefore, companies (as large water users) are especially asked to understand the impacts generated by water's use, to be part of the solution to water problems and to work collaboratively and transparently with other actors to have more sustainable management at the basin scale [51]. In this context, companies are asked to act as custodians of water as a public good [52].

2.2.2. Experimentalist Governance

Experimentalist governance (EG) has been defined as a recurrent process of goal setting and periodic revision based on learning, that is achieved through a comparison of the different alternatives existing under different contexts [53]. This governance approach corresponds to a form of coordination based on practice and experimentation, in the sense that "systematically provokes doubt about its own assumptions and practices [. . .] and treats all solutions as incomplete and corrigible" [42]. EG constantly adjusts its outcomes and means to achieve them through social learning, therefore, its main objective is to achieve a systematic way of constant reformulation and iteration [42].

In terms of the relationship among actors, EG promotes a decentralized and diverse structure, including various sources of resource and expertise [54]. EG, also called demo-

cratic experimentalism, would be a response to the demands from political objectives and methods that can no longer be pre-determined. Instead, they have to be discovered during the problem-solving process [55], requiring a high degree of commitment from the involved actors to advance in water management. In EG, actors performing at the lower-level are granted enough freedom to create place-based mechanisms to achieve all-encompassing framework outcomes, and sharing their experiences enables policy learning [56].

Some authors point out that EG is practiced through an iterative cycle, which consists of five steps [42,53]: first, actors discuss and agree about a common problem; second, local and central actors set overall goals and metrics for their implementation in a provisional way; third, local actors (public and/or private) are free to move towards the resolution of these objectives in any way they deem appropriate; fourth, due to their autonomy, local actors should regularly inform about their performance and participate in a peer review process to compare their results with those of others who use different means to achieve the same objectives. Finally, objectives, indicators and decision-making processes are periodically reviewed based on the challenges and opportunities revealed, and the cycle is repeated. In this sense, an expected outcome for EG is to perform this cycle in a coherent way, through active participation and deliberation; thus, leadership is taken by local actors in this process.

2.2.3. Polycentric Governance

Polycentric governance (PG) corresponds to complex systems where governance is related to different purposes, organizations and territories that jointly interact to form new systems, characterized by various decision centers at different levels [57]. According to Ostrom et al., initiators of the concept of polycentrism, this occurs when a large number of decision-making centers are formally independent from each other [58]. According to Ostrom, in a polycentric system the responsibilities at different levels of government (local, regional, national and international) are organized in such a way that they can efficiently provide public services at the local level [59]. In this sense, the main objective of PG is to effectively distribute decision-making at different levels to address water-related problems.

These different decision-making centers are composed by actors who are capable of resolving conflicts and regard each other in competitive and cooperative relationships [60]. PG distributes duties and capabilities in a way that perverse incentives and information issues at one level are counterbalanced by positive incentives and information competencies for actors at other levels [61]. This is possible through the development of nested institutions, which are norms and rules that are part of a broader system, so the local is connected to what is located on a larger scale [17]. In this sense, connection and consistency are expected outcomes for PG, since they help to achieve better responses than those observed at either highly centralized or fully decentralized structures [62].

Another characteristic of PG is that traditional and local knowledge is much more likely to be considered, since it encourages the exchange of knowledge at different spatial-temporal scales [63]. In this framework, it is important to emphasize that PG is connected to experience [64], since knowledge promotes social learning and therefore encourages trust and cooperation between actors. From this, decision-making centers are composed not only of formal bodies, but also by informal forms of organizations composed of water user groups [62,65]. In these terms, leadership in PG is more diverse than other governance perspectives, because decision-making is not concentrated in one specific group of actors and/or levels.

2.2.4. Metagovernance

Metagovernance (MG) is aimed towards the design and management of a composition of different processes related to three modes of governing: (i) hierarchical, (ii) market-based governance, and/or (iii) network-based governance, which differ in the degree of formality of institutions and actors involved and the logic of interactions between them [20,42,66]. This "governance of governance" approach [67] provides an understanding about how

these governance modes relate, interact and coordinate to achieve more effective water management.

The hierarchical way of governing water is common in state structures. The fundamental idea is to preserve and strengthen public responsibility to ensure water allocation to all sectors of society [68]. This mode of governance is reliable, highly predictable and based on technocratic knowledge and the expertise of those who advise those who govern [20].

Market-based governance favors water-related decision making in a decentralized way [67]. It is based on encouraging the regulatory function of the free market through competition between the different water users, favoring resource distribution based on the greatest economic value [69]. This approach uses formal and informal rules designed to guide the economic behavior of individuals, organizations and governments [70]. Water markets belong to this mode of governance, and its proponents argue that it has been increasingly used as a strategy to deal with water scarcity, allocating water in an economically efficient way [71].

Network-based governance corresponds to the management of complex networks, which are composed of a large number of actors at local, regional and national levels, constituting political groups to civil society [66]. In this mode of governance, actors from the state, markets and civil society interact through conflict negotiations, within a framework of formal and informal rules, norms, knowledge and social imaginaries, facilitating the creation of self-regulated policies [72].

These three modes of governance have a particular way of addressing the relationship among actors. In hierarchies, formal institutions of the state take center stage and the actors involved in water resources management mostly belong to the public sector. Markets, on the other hand, give less predominance to public actors in decision-making, considering the role of the state as a protector of property rights. In network governance, civil society actors are involved in resource management decisions through informal institutions, which are generally based on traditional knowledge, transmitted orally and formed at the local level [73].

The main objective of MG is to take advantage of each of the attributes of each mode of governance, relating and applying them in a joint and coordinated manner [20]. In this sense, the relationship among actors in MG becomes complex, therefore, the figure of a meta-governor (usually state agents) takes the lead [66]. It is important to highlight that this leadership is not observed at the decision-making level, but rather at the coordination level, to achieve the expected outcome to legitimize and balance this hybridization to face specific environmental problems [66].

2.2.5. Adaptive Governance

Adaptive governance (AG) is a process that aims to create transformability [74]; this means, the capacity to create new systems (i.e., new ways of living) when economic, ecological and/or social conditions have created an unsustainable system [40]. Its premise is that, for managing a system, it is necessary to know it in depth [75]. This form of governance provides an alternative to the conventional paradigm that separates the creation of knowledge (the research) from its application (management) and, therefore, has been promoted as a necessary basis for sustainable development [76–78]. In this sense, we understand that the expected outcome of AG is to achieve sustainable societies.

AG is regarded as an ongoing problem-solving process in which institutional arrangements and ecological knowledge are verified and reviewed in a dynamic and self-organized process of learning by doing [79]. The adaptive paradigm conceptualizes WS as a term that is constantly generating new objectives according to the changing biophysical, social and institutional challenges and opportunities, regarding WS as a process rather than an end to achieve [76]. AG invites decision-makers to leave the conventional paradigm behind, moving towards new ways of acting (integrated and informed), learning (part of doing and inclusive), understanding (social learning) and working together (integrated and inclusive).

In this sense, AG encourages decision-making processes which are based on innovation to better address complex environmental problems [42].

In terms of the relationship among actors, AG also implies a broader range of stakeholders who play a role in decision-making, encouraging a form of social coordination which connects individuals, agencies and institutions at multiple organizational levels and supports flexible and learning-based approaches to water management [80]. Consequently, AG concentrate leadership on the groups of actors that provide innovative ways of managing water, however, they are challenged to provide feedback and make informed and conscious decisions [81].

3. Methods: Assessing Strengths and Failures of Each Governance Approach

Based on the features of each governance approach, we identified the main strengths and failures in order to integrate their contributions to a "good enough water governance". The analysis of each governance approach shows similitudes and differences in key elements that may contribute to the OECD water governance dimensions. The differences among their focus, leadership and expected outcomes (Table 1) highlight the interdependency that exists between the different actors that compose a river basin. From this, we understand that the association among actors and their involvement in water governance is fundamental to achieve the expected outcomes.

Table 1. Key elements of each governance approach.

Governance Perspective	Focus	Association between Actors	Leadership	Expected Outcomes
Corporate	Transparency and corporate responsibility	Interdependency	Corporation's employees and suppliers	Corporations as custodians of water
Experimental	Constant reformulation and iteration	Commitment	Diverse at the local level	Active participation and deliberation
Polycentric	Decision-making distribution	Interdependency	Diverse at multiple scales	Distributed, connected and consistent governance
Meta–governance	Coordinate and balance hierarchies, markets and networks	Complexity	Meta-governor (state as coordinator)	Legitimate and balanced stability among hierarchies, markets and networks
Adaptive	Adaptability and transformability	Complexity and interdependency	Innovative actor/group of actors	Sustainable societies

Strengths observed in different governance approaches can mean opportunities for achieving a "good enough water governance" that advances towards WS; however, they could present some weaknesses resulting in governance failures, defined as "the ineffectiveness of governance goals, a governance framework or the management thereof, to achieve policy goals" [82]. Specifically, for WS, a governance failure occurs when the institutional dimensions in water management and decision-making do not effectively consider the needs of all actors (especially the most vulnerable), encompassing administrative economic and public policy dimensions [83]. Taking this into consideration, governance fails when it does not consider different perspectives in a decision-making process that involves institutional and organizational aspects, which are reflected through mechanisms and policies related to water management. Thus, coordination at multiple levels must be considered.

4. Results and Discussion

Figure 1 illustrates the analyzed approaches and their relationship to the concept of "good enough water governance", which is embodied by the three water governance

dimensions proposed by the OECD [19]. In this figure, the colored areas represent the strengths that help each governance theory to contribute to the achievement of these dimensions, while the white areas represent those dimensions that are not covered by each governance approach, due to potential failures. These approaches can be adequately integrated if they are combined to overcome the challenges of its exclusive application.

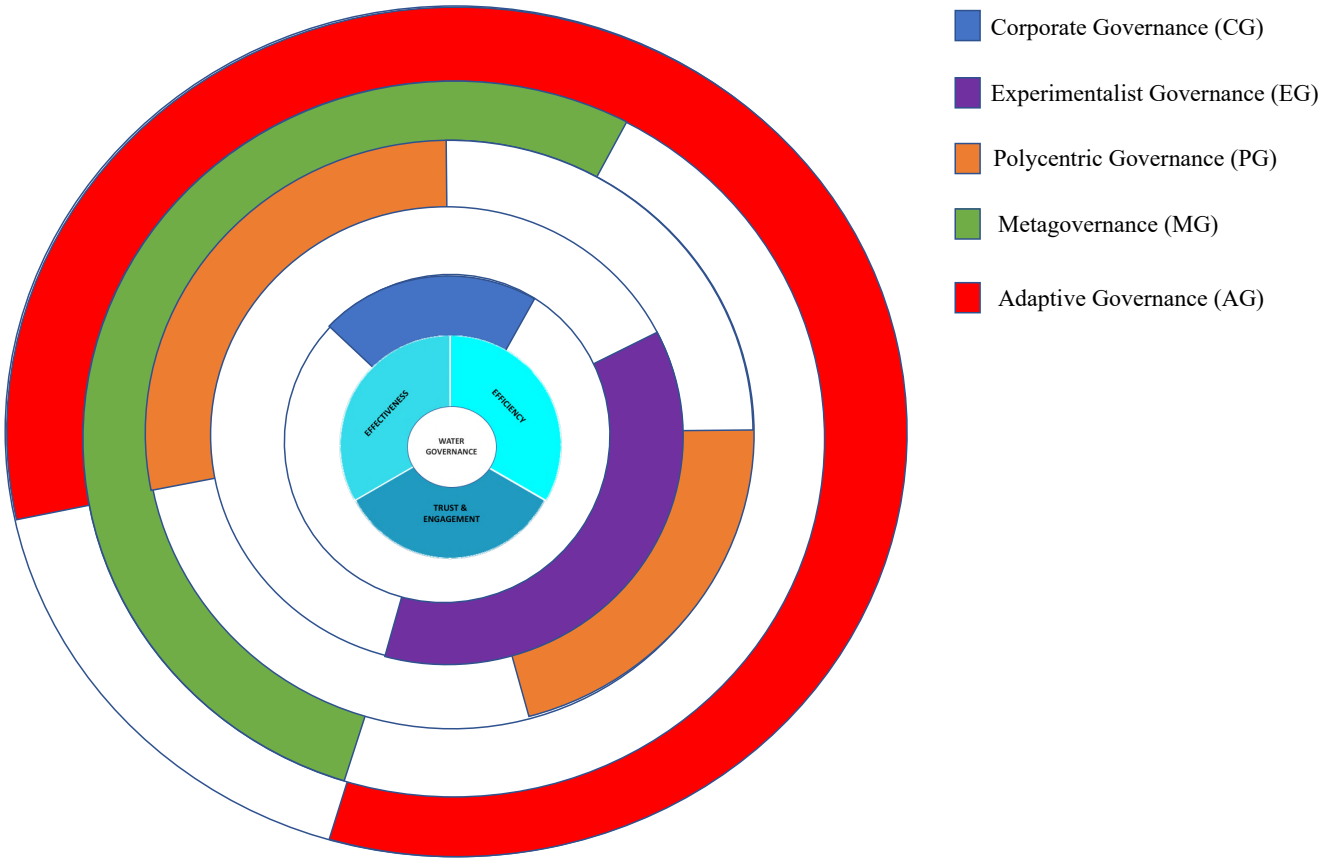

Figure 1. Water governance has different approaches on three dimensions proposed by the OECD, which can be adequately integrated if they are combined to overcome the challenges of its exclusive application. Source: Adapted from the OECD [19].

Figure 1 shows the relationship among the five governance approaches. The blue area represents CG, whose main objective is to create a regulatory and operational framework, so that companies, owners and regulators are more transparent, accountable and efficient in the decision-making processes. The main strengths of CG include the relationship between a company, its shareholders and society, as well as the promotion of fairness, transparency and accountability, the use of mechanisms to "govern" managers and the guarantee that the interests of key stakeholder groups are considered with the actions taken by the company [84]. Furthermore, the opportunity to engage companies in CG includes the consideration of issues about the regulatory environment, appropriate risk management measures and the responsibility of the senior manager and the board of directors [85].

A condition that occurs in corporate governance systems is that ownership and control are separated: the former lies with distant and diffuse shareholders, while the latter is exercised by hired managers [86]. This could mean a strength in terms of enabling economies of scale when large firms are functioning and the hiring of talented and highly qualified managers; however, this separation could enhance problems such as incentive misalignment, managers following self-serving behaviors and concentration of power in managers who lack the necessary knowledge to perform in changing environments [87].

This governance failure could be particularly important when CG seeks to safeguard accountability and respond to WS problems.

Another issue in CG is related to privatization of water and sanitation services, which are essential for other actors in the river basin, who act as customers/clients. Taking into consideration that the most economically efficient solution is not necessarily the most ethical one, company's activities must consider political economy and equity factors to deliver socially desirable outcomes in water management [85,88,89]. In this sense, CG could be appropriate in river basins that have an institutional framework in which the state plays an active role as regulator [89].

CG could be a good alternative to achieve effectiveness and efficiency. In relation to effectiveness, the clear allocation and coordination across responsible authorities and the clear distinguishing of roles and responsibilities can be observed if companies' activities are regulated by the state and take responsibilities as custodians of water. In terms of efficiency, companies usually have financial resources to update and share water-related data and information to guide, assess and improve water policy. However, some of its governance failures do not allow effectiveness to be completely addressed, in relation to achieving cross-sectoral coordination between environmental policies, other sectors (i.e., agriculture, energy, health) and the corporation's activities, and in relation to achieving the capacity to meet complex water challenges that need other actors' involvement. In terms of efficiency, CG could fail to ensure that regulatory frameworks are implemented and enforced in pursuit of the public interest, and it is not forced to adopt innovative water practices. The practice of CG sometimes becomes an obstacle to addressing trust and engagement, when CG does not involve the needs of local actors that do not perform as clients/customers. The lack of capacity to address the latter two dimensions can be solved if it is complemented by EG (purple area), since it promotes innovative practices and the active involvement of local actors in water management.

The main strength of EG is its deliberation. It promotes openness to reconsider settled practices and use the experiences of actors and their reactions to current problems to generate novel possibilities for solutions [53]. This attribute is suitable for dealing with the complexity and uncertainty of climate change effects, because it takes into consideration the local social–ecological conditions of the river basin and can adapt faster than other governance regimes. Other advantages of EG are: it provides space for diversity by adapting common goals to varied local contexts instead of imposing a one-size-fits-all solution; it creates a system for coordinated learning from local experimentation, comparing different approaches to advance to the same outcome; the provisional character of the goals and the means for achieving them are revised by experience, thus problems identified in one phase of implementation can be amended in the next iteration [90].

A failure in EG could appear when actors' interests become too diverse to promote the common interest, thus additional incentives are needed to engage these actors in collective problem solving [91]. In this sense, the transformative attribute of EG depends on other forms of governance (i.e., hierarchies) to be effective [91]. In this case, as we explain below, the hierarchical component and the coordination attributes of MG provide a good alternative to support EG.

In relation to the OECD water governance dimensions, EG could be a good alternative to achieve efficiency, trust and engagement. In terms of efficiency, EG could promote the obtention of policy-relevant water-related data and information to guide, assess and improve water policy; in addition, due to its experimental approaches, it helps to promote the adoption of innovative water governance practices. In terms of trust and engagement, due to its deliberative process, it could take local actors' opinions into consideration to promote stakeholder engagement in water policy design and implementation and promote regular monitoring and evaluation where appropriate, and to share results and make adjustments where needed. However, the diversity of actors' interests does not allow EG to address effectiveness, since it becomes an obstacle to clearly allocate and distinguish roles and responsibilities, and to foster cross-sectoral coordination and thus adapt the level of

capacity to respond to complex water challenges. Also, EG cannot be completely efficient, because the possible lack of coordination could create regulatory frameworks that do not represent the public interest. This affects the capacity to overcome trade-offs across water users, so EG cannot entirely address trust and engagement. In spite of these issues, the lack of effectiveness can be solved if EG is complemented with PG (orange area), since it promotes coherence and soundness.

The main objective of PG is to distribute decision-making. The main strengths of PG are the promotion of structures where actors can innovate through experimentation and learning, and the distribution of decision-making authority reduces costs of enforcing rules by reaching legitimacy at local levels of governance [62]. In addition, PG's structures promote collaboration among policy stakeholders and equitably distribute the resources generated by policy interactions [92]. Bringing autonomy in decision-making at the local level can enhance reciprocity and voluntary cooperation and reduce failures in the implementation of rules and norms, compared to the high cost associated with the use of command-and-control mechanisms [60]. This autonomy can strengthen the sense of self-determination, and thus generate motivation to cooperate with the decisions made [93].

Besides their attributes, PG has some associated failures, such as high transaction costs related to coordination, especially in larger or geographically dispersed systems [94]. Another governance failure that could emerge is the dispersion of responsibilities, which can be challenging in terms of holding decision-makers accountable for their performance [94]. Meuleman describes some cases where dialogues culminate in never-ending talks without results, and where there were too many demands from quite a small group of participants [82]. Pahl-Wostl et al. state that problems of accountability may arise in complex polycentric systems when rules do not match with the decentralized decision-making processes [36].

In relation to the OECD water governance dimensions, PG can help to achieve effectiveness, efficiency and trust and engagement; in terms of effectiveness, due to the promotion of nested institutions and collaboration, PG brings coherence through cross-sectorial coordination among different users. PG's mutual monitoring and learning mechanisms [95] allow adaptation of the level of capacity to complex water challenges. In this sense, as we mentioned above, PG's coherence could help to avoid EG failures, because it helps to reach a common understanding of challenges and opportunities across national, regional and local levels, valuing different local experiences. In terms of efficiency, PG ensures that water management regulatory frameworks are effectively implemented in pursuit of the public interest, and in terms of creating trust and engagement, PG promotes stakeholder engagement in water policy design and implementation.

However, PG cannot be completely effective, because it could present failures related to the distinguishment of clear roles and responsibility for policy implementation, due to the numerous decision-making centers and the dispersed responsibility. In terms of efficiency, the characteristics of PG do not ensure the production and updating of relevant water data or the implementation of innovative water practices. However, these could be easily implemented if PG governance structures followed the iterative cycle of EG (identify problem—set broad goals—locals implement—report and peer review—revision of goals) and the continuous focus on monitoring. In terms of trust and engagement, the excessive dispersion of roles and responsibilities and potential accountability problems can be a problem to encourage water governance frameworks that help manage trade-offs among users. In this sense, MG (green area), through the adequate combination of hierarchies, markets and networks, could promote the reduction of trade-offs, as is explained below.

The hybridization attribute of MG allows each governance mode to be taken advantage of. Hierarchies are sometimes used to solve conflicts that require immediate actions and networks can develop more solutions to the same problem, while markets have been used to encourage civil society's involvement [66]. Investing in network-based governance has also been considered for creating trust of different actors, to increase the acceptability of hierarchical interventions when crises have arisen [72]. Also, a hierarchical intervention

has been promoted when "never-ending talks" have occurred in network processes, and a network intervention has been used when a solution to a problem has not been broadly accepted through a hierarchical process [66,82]. In this sense, MG promotes democratic, participatory and context-specific decision-making through the coordination of collective action in water resource management.

MG can have some failures related to the inefficiency of efforts to combine hierarchical, network and market governance. The underlying culture influences the feasibility of certain forms of hybridization. For instance, in a consensus society, it is very difficult to implement a hierarchical mode of governance [66]. At the sectoral level, every policy division may have its own preferred governance mode, obstructing its coordination. For instance, a ministry of economic affairs may prefer a market-based governance style, while a ministry of environment may have an inclination for a hierarchical style (norms, command-and-control mechanisms, standards). From this, metagovernors have to be informed about the history, current dynamics, possible futures of a decision-making process, organizational characteristics and the type of policy problem [66]. This means that metagovernors have to be reflexive, understanding that knowing about a system could help them to adapt to constant changes and, therefore, combine and switch governance modes in a flexible way.

In relation to the OECD water governance dimensions, MG encourages effectiveness, efficiency and trust and engagement. In terms of effectiveness, MG promotes the clear allocation and distinguishment of roles and responsibilities for water policymaking and coordination across responsible authorities, policy coherence through cross-sectoral coordination among different users and adjusts the level of capacity to address complex water challenges. In terms of efficiency, the role of the metagovernor in MG seeks to ensure that water management regulatory frameworks are effectively implemented in pursuit of the public interest. In terms of trust and engagement, through a suitable hybridization of hierarches, markets and networks, MG tends to encourage governance frameworks that help manage trade-offs among users, areas and generations. However, the main goal of MG is to coordinate and balance hierarchies, markets and networks, therefore, in terms of efficiency, the production and update of water relevant data and the use of innovative water governance practices do not seem to be a priority. Governance failures could impede MG's complete achievement of trust and engagement, because of the potential difficulty to, for instance, engage stakeholders that used to organize in networks and do not accept hierarchical organizations or market-based instruments to solve a particular problem. Trust and engagement also relate to the promotion of regular monitoring and evaluation of water policy and governance, and MG could achieve it through the support of the innovative and flexible characteristics of AG (red area). AG could help MG in its decision-making process to react effectively to the social–ecological characteristics of the changing environment, achieving efficiency and trust and engagement.

In AG, decision makers develop the capacity to confront the high variability of uncertainty, which is characteristic of complex social–ecological systems [96]. AG systems self-organize as network structures that connect stakeholders at multiple organizational levels, where key persons have leadership, trust, vision and meaning and create a learning environment where knowledge and experiences develop a common understanding in decision making [79].

AG is focused on experiential and experimental social learning, as well as collaboration, which is inclusive and observed at horizontal and vertical levels. Both features are necessary to understand and respond to complex social–ecological systems. This is possible through the development of innovative institutional arrangements and incentives across diverse scales of space and time, monitoring and assessment interventions and opportunities to link science and policy [97]. In this sense, AG encompasses the innovation attributes of EG.

It is important to mention some similarities among AG and PG and the network-based governance mode in MG. PG systems are regarded as complex adaptive systems with emergent, self-organizing properties [61], which is coincident to some statements about

AG relying on polycentric institutional arrangements operating at multiple scales [65,93]. Additionally, AG and polycentricity are supported by network structures [80,94] and AG has been considered as a variation of the network-based governance mode in MG [82]. In this sense, AG relies on PG and network structures to achieve sustainable societies, and, in turn, assists PG to adopt innovative water governance practices and regular monitoring and evaluation.

AG is the governance perspective that most encompasses the OECD water governance dimensions. It addresses effectiveness in terms of policy coherence through cross-sectoral co-ordination among different users and adapting the level of capacity to complex water challenges. It addresses efficiency in terms of produce, update and share policy-relevant water-related data as information to guide, assess and improve water policy, ensuring that water management regulatory frameworks are effectively implemented in pursuit of the public interest and promoting the adoption and implementation of innovative water governance practices. It addresses trust and engagement in terms that promote stakeholder engagement in water policy design and implementation and promote regular monitoring and evaluation where appropriate, to share results and make adjustments where needed.

Although AG has major attributes to be regarded as a "good enough water governance", some critiques have arisen in terms of operationalizing the theory. AG is regarded as a process that is often neither very precise nor stable and does not give clear guidance on follow-up actions [98]. Some scholars state that AG should go beyond understanding how things are, to focus on understanding how things ought to be, since it lacks the use of repeated patterns that could help to understand how governance can stop failing [99]. In addition, it is not very clear whether AG could address unequal power relations underpinning governance structures and coordination of institutions [98]. In this sense, the coordination attributes of MG could be a complement of AG to achieve a clear distinguishment of roles and responsibilities for water policymaking and coordination across responsible authorities, and to encourage governance frameworks that help manage trade-offs among users, areas and generations. Therefore, if AG is complemented with MG in this way, it is possible to completely achieve effectiveness, efficiency and trust and engagement.

Taking all of the above into consideration, it is important to highlight the contribution that each governance theory can provide towards WS in a river basin. AG and EG are adequate to respond effectively and generate resilience towards uncertainty, mitigating climate change effects through innovation. Polycentrism shows us the importance of informal institutions that have been created through local knowledge, which is suitable for water management at the river basin scale, and which are generally invisible due to the predominance of formal institutions, which are generally acting at the macro level. MG expresses that a good coordination of different modes of governing water can generate adequate responses to specific problems. On the other hand, CG promotes that large corporations (that generally consume more water) take a more active role in the conservation of ecosystem services.

Taking this into consideration, depending on their social-ecological characteristics, there are problems that could be solved using a combination of two or three governance perspectives, while others would need to use a combination of the five governance perspectives that we show in this paper (Figure 2).

Figure 2 illustrates two possible combinations of governance approaches aimed at addressing specific WS issues. For instance, a river basin where corporations are the major users could need a CG to promote their involvement in water management and act as custodians of water. CG, in this case, can be complemented with an EG that promotes innovative practices in corporative stewardship as well as, in the case of corporation that perform at the national and international levels, the inclusions of local perspectives (Figure 2a). On the other hand, complex problems that need adaptation and transformation in accordance with the changing environment need an AG approach that promotes polycentric structures coordinated by a metagovernor that has enough knowledge to hybridize different governance modes to be flexible and to adapt (Figure 2b).

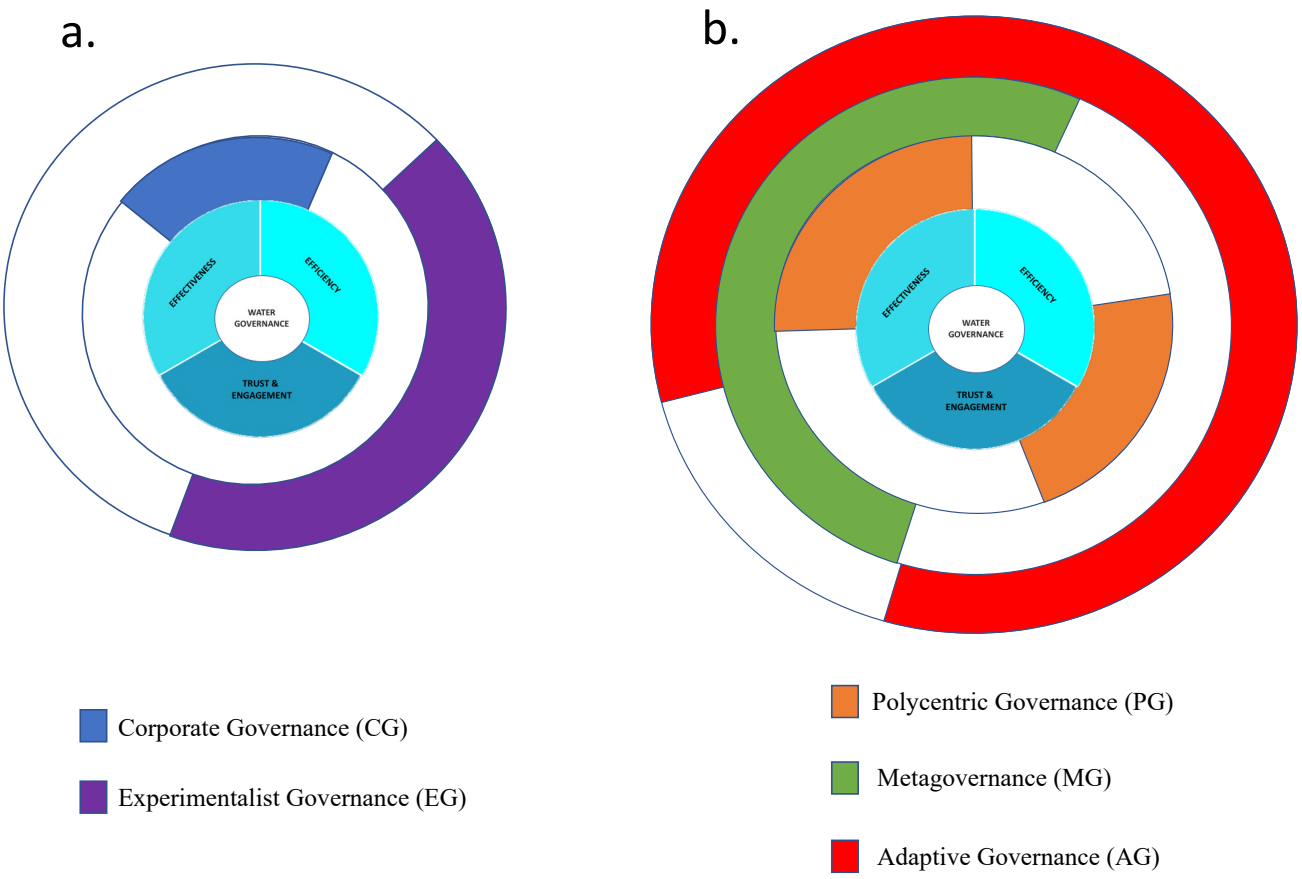

Figure 2. Two possible combinations of governance approaches to address specific WS issues. (**a**) combination of CG and EG; (**b**) combination of PG, MG and AG. Source: adapted from the OECD [19].

5. Conclusions

To advance towards water security, IRBM must recognize the multiple interconnections and associations that exist between ecological and socioeconomic systems. This should be determined by a process of sustainable and multi-scaling governance, which considers freshwater ecosystems as complex social–ecological systems and has varied responses to change and uncertainty, and where power and responsibility must be shared between water resource users and government entities in order to achieve more collaborative and coordinated actions that can better adapt to uncertainty.

In this study we observed that a combination between MG and AG could encompass the OECD water governance dimensions, complementing each other to improve strengths and to overcome failures. In this sense, an integration of these governance theories can achieve "good enough water governance", in terms of understanding it as a process and a means to operatize IRBM and advance towards WS. However, although CG, EG and PG do not encompass the three water governance dimensions, their combined application could be considered according to the problem to be solved (i.e., to achieve companies' engagement, perform local innovative practices, etc.). This integration must be dynamic, understanding that it will not necessarily work for all realities, so it is important for decision-makers to consider the context-specific ecological and socioeconomic characteristics of each territory.

There is still no consensus regarding a good water governance; however, we highlight that we can achieve a "good enough water governance" system, focusing on the process and integrating different governance approaches that have been proposed over time, which differ in their objectives, interaction between actors involved and how power and responsibility are distributed between them. For a "good enough water governance" process to exist, more instances must be generated for debate and participation, to include

these different perspectives in a decision-making process that responds adequately to the social–ecological context. We invite decision makers at the national, regional and local levels to review the different proposals that exist to govern water, and to consider that focusing on one sole approach could generate water insecurity situations related to the minimal observation capacity offered by a small number of actors.

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